ACCEPTANCE AND USAGE OF GREEN TECHNOLOGY IN BRICK KILN FIRMS OF PUNJAB: AN APPLICATION OF THE UNIFIED THEORY OF ACCEPTANCE AND USE OF TECHNOLOGY (UTAUT) MODEL

Thesis Submitted for the Award of the Degree of

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in

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DECLARATION

I, hereby declare that the presented work in the thesis entitled "**Acceptance and Usage of Green Technology in Brick Kiln Firms of Punjab: An Application of the Unified Theory of Acceptance and Use of Technology (UTAUT) Model**" in fulfillment of degree of **Doctor of Philosophy (Ph.D.)** is outcome of research work carried out by me under the supervision of Dr. Shamily Jaggi, working as Professor, in the Mittal School of Business, Faculty of Management, Lovely Professional University, Punjab, and Dr. Arvind Kumar, Assistant Professor, National Institute of Technology, Rourkela, Odisha, India. In keeping with general practice of reporting scientific observations, due acknowledgements have been made whenever work described here has been based on findings of other investigator. This work has not been submitted in part or full to any other University or Institute for the award of any degree.

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CERTIFICATE

This is to certify that the work reported in the Ph.D. thesis entitled "**Acceptance and Usage of Green Technology in Brick Kiln Firms of Punjab: An Application of the Unified Theory of Acceptance and Use of Technology (UTAUT) Model**" submitted in fulfillment of the requirement for the reward of degree of **Doctor of Philosophy (Ph.D.)** in the Mittal School of Business, is a research work carried out by Ajay Kumar, 11815119, is bonafide record of his/her original work carried out under my supervision and that no part of thesis has been submitted for any other degree, diploma or equivalent course.

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ABSTRACT

It is estimated that India has more than 100,000 brick kilns producing about 250 billion bricks annually, employing about 15 million workers and consuming about 35 million tons of coal annually. The brick industry is growing as the demand for bricks is increasing in the towns and villages due to the fast economic growth, urbanization and prosperity. It is alarming to note that 300 mm depth of fertile top soil in India will be consumed for burnt clay brick production in about 60 years. Usually, brick kilns are situated in rural and/or periphery of urban areas in the country. These brick kilns mostly burn coal as a fuel source, resulting in SO_2 and particulate matter (PM) emissions, causing poor air quality and associated health problems.

Government and number of agencies are trying to find out the solutions for brick industry, in order to reduce the pollution and erosion of soil. Even different types of green technologies and machineries are available in the market. In Punjab around 2800 brick kilns are in operations. Brick kiln which are registered has control of government. Government issues different types notices and instructions to reduce emission and conservation of soil and water. PPCB and NGT have also interference in brick kiln operations, but still there are some brick kilns which are using old types of technologies in production of bricks. The objective of this study is to ascertain determinants of green technology adoption by using UTAUT (unified theory of acceptance and use of technology) model.

The goal led to development of certain objectives stated as;

1. To investigate whether Performance Expectancy (PE), Effort Expectancy (EE) and Social Influence (SI) affects decision maker's behavioural intention for green technology in brick kiln firms.
2. To examine the moderating role of demographics (age, experience and education) in the defined relationships among constructs taken.

3. To examine the moderating role of voluntariness to use and firm size in the defined relationships among constructs taken.
4. To investigate the influence of facilitating conditions (FC) on actual usage of the green technology.

Structured schedule is taken to for the collection of data, appropriate sample size measures and suitable data collection technique has been incorporated. Data was gathered through physical form. All the necessary measures are taken for refining the raw data. Furthermore, analyses according to the presuppositions are done using the software SPSS and SmartPLS-4.0.

The results of this study are in sync with the previous practitioners stating significant impact of UTAUT model's constructs in adoption of green technology. Result of this study show that performance expectancy and effort expectancy has a significant impact on behavior intention. On the other hand, social influence do not have any impact on behavior intention of users to adopt green technology, while facilitating conditions have direct impact on use behavior of users.

In moderation, two moderators of UTAUT, experience and voluntariness of use is taken, while two new moderators, education and firm size are added. Experience has significant impact upon behavior intention, while voluntariness of use does not have any impact on behavior intention. On the other hand, education as moderator impact users intention to actual use of technology, while firm size do not impact use behavior of users. This implies that size of firm does not matter in adoption of green technology.

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Dated: October, 2023 Ajay Kumar

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INTRODUCTION

India places second worldwide in brick production with 200,000 brick kilns, producing 250 billion bricks annually (Reuters, 2019). With the process of rapid industrialization and urbanization, the ever-growing population demands millions of new buildings and houses every year. It has made manufacturing activity one of the most thriving businesses in India. Due to this, the building material industry is among the quickest expanding

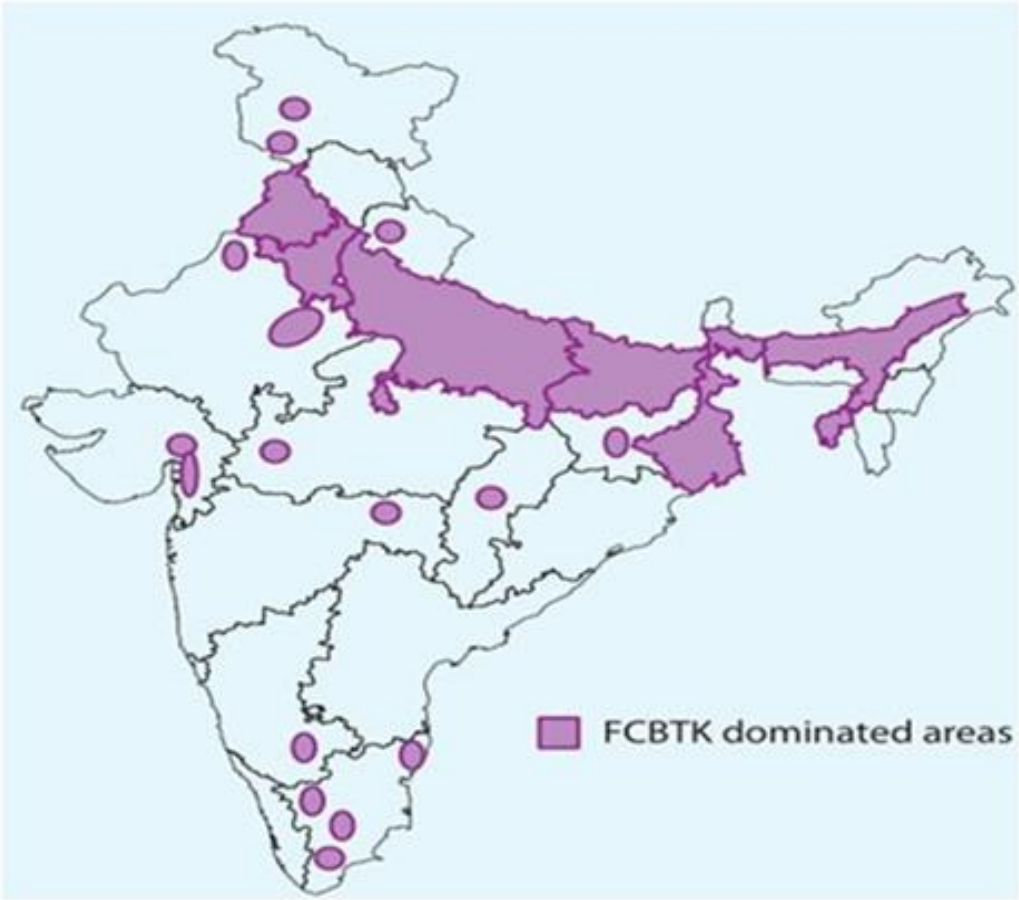

Figure 1.1: FCBTK dominated regions in India.

(Source: Greentech Knowledge Solutions)

sectors. These industries are major consumers of natural resources, energy, labor and

capital. According to Eco-business data the industrial sector in India is responsible for 15% of total black carbon emission; with brick kilns are being responsible for 2/3 of those emissions, or 9%. The industry uses 35–40 million tons of coal annually.

About 65% of India's bricks are produced in West Bengal and Uttar Pradesh, with the remaining 35% coming from Peninsular and Coastal India. About 9–10 million people are employed in India's brick industry, which is characterized by the use of manual labour and antiquated technologies (GKSPL, 2018). The FCBTK (Fixed Chimney Bull Trench Kiln), a kind of continuous kiln, is used to make more than 70% of all bricks manufactured in India. The Gangetic Plains and a few other locations in the nation are where FCBTKs are2 most prevalent.

In the Peninsula region, intermittent kilns like clap kilns, which make small batches of bricks, are commonly employed and account for around 25% of the world's brick production. Less than 5% of all bricks are produced using other firing techniques, like the VSBK (Vertical Shaft Brick Kiln), Zigzag kiln and Hoffman Kiln.

1.1 Brick

For thousands of years, bricks have been utilized as construction materials. Around 7,000 years ago, in the Middle East, bricks were first recorded to be produced from a combination of straw and mud. These early bricks were sun-dried and worked well for basic constructions, but they lacked strength and durability. About 4,000 years ago, the first people to employ burnt bricks were the ancient Egyptians. To create sturdy and long-lasting bricks, they mixed straw and mud, shaped the mixture, and burned it in kilns. Larger and more complex constructions, like the pyramids and temples, were made possible by this. Fired bricks were also utilized by the Greeks and Romans, with the Romans using them most frequently.

During the Middle Ages, brick production fell in Europe as preference grew for other construction materials like stone and wood. But during the Renaissance, when architects like Brunelleschi and Palladio employed brick extensively in their designs, it saw a comeback. The Industrial Revolution saw the development of new technology such as

steam-powered brick production machines, which had a significant impact on the brick industry. Because of this, bricks could be produced in large quantities, contributing to the building boom of the late 19th and early 20th centuries.

Bricks are still widely used in construction because of their strength, resilience, and adaptability. Although autoclaved aerated concrete (AAC) and fiber-reinforced polymer (FRP) bricks are emerging technologies, conventional burned bricks remain a common application (Fatima, 2011; Brick Architecture, 2017; Nemachin royal, 2020).

1.2 Brick Kilns

A brick kiln is a location where clay or other resources are used to make bricks. Bricks are made in a kiln by combining the raw ingredients (like mud) with water, shaping the mixture into the required shape, letting it dry in the sun, and then fire it in a high-temperature kiln. The bricks are fired for many days at high temperatures, usually between 1472 and 2192 degrees Fahrenheit, in a furnace called a kiln. The bricks are strengthened and made sturdy enough for use in construction by this procedure, which also helps to harden them. Brick kilns can be found in many parts of the world, and have been used to make building materials for thousands of years. But brick kilns may also be harmful to the environment and the health of the workers, particularly if they are used without the necessary safety precautions or rules in place. Certain brick kilns are linked to problems including labour exploitation, deforestation, and air pollution, particularly in developing nations.

The most essential aspect of the brick-making process is the kiln, which is where bricks are burned in vast, permanent structures (Kioupis, 2018). Green bricks are burned in a fixed chimney to produce a solid final product with minimum shape change. Since the Indus Valley Civilization, brick making has been one of the world's oldest professions (2500-1500 B.C.).Bricks that had been burned were used to build tombs and temples by the ancient Egyptians and Mesopotamians (Solodky, 2006). Although the shape, design, and weight of bricks have changed over time, the manufacturing method has remained relatively unchanged. The brick kiln is where bricks are made, processed, and baked.

In India there are around 200,000 (Reuters, 2019), out of which mostly kilns are FCBTK (Fixed Chimney Bull Trench Kiln). Kilns consume a lot of coal, which greatly increases the amount of carbon dioxide (CO2) and particulate matter (PM),as well as nitrogen oxide (NOx),Sulphur dioxide (SO2), carbon monoxide (CO), and black carbon (BC)discharges. The pollutants contribute to global warming in addition to endangering the health of the local population, the environment, and the workers. For several types and classifications of brick furnaces, the Government of India and the MoEF (Ministry of Environment and Forests), has issued regulations for chimney height and SPM (suspended particulate matter) emissions.

Table 1.1: Emission standards set for brick kilns by MoEF 2015.

Technology and size	***SPM emission standard***
Fixed Chimney Bull's Trench Kiln (FCBTK)	
Large and medium size (production >15,000 bricks/day)	<750 mg/Nm^3
Small size (production <15,000 bricks/day)	<1000 mg/Nm^3
Vertical Shaft Brick Kiln (VSBK)	<250 mg/Nm^3
Down-draft kiln	<1200 mg/Nm^3

(Source: Ministry of Environment and Forest).

1.3 Type of Brick Kilns

Brick kilns fall into two categories: intermittent and continuous. Continuous kilns are more efficient than intermittent ones because they have features that allow for the recovery of heat from flue gases as well as the heat found in burned bricks. Brick kilns can be categorized into the following classes on the basis of the utilized technology:

A. Intermittent Kilns

Intermittent brick kilns (IBKs) are a type of brick-making technology commonly used in developing countries. They are called intermittent because they are periodically fired, as

opposed to continuous kilns that operate continuously. These are typically made from bricks, with a rectangular or circular shape, and are used to fire clay to produce bricks and other ceramic products.

Such types of kilns have a number of advantages over other continuous kilns. They are generally less expensive compare to other kilns to build and operate, require less fuel, and have a smaller environmental impact. But the drawback is that they are less efficient than continuous kilns and may produce lower quality bricks. Such types of kilns have also been criticized for their impact on air pollution and human health. The process of firing bricks in IBKs produces significant amounts of air pollution, including particulate matter (PM), carbon monoxide, and other harmful gases. Those who live and work close to such kilns may have negative health effects as a result. Efforts are being made to improve the design and operation of IBKs to reduce their environmental impact and improve the quality of the bricks. For example, some newer designs incorporate better insulation to reduce fuel consumption and emissions, and some use cleaner fuels like natural gas instead of wood or coal. However, more research and investment is needed to make IBKs a sustainable and viable option for brick-making in developing countries (Mitra and Valette, 2017).

B. Continuous Kilns

Continuous type kilns can be operated on either a moving ware or moving fire principle. The Hoffman, BTK and Zigzag kilns are all based on the moving fire theory. While the bricks shift in the Tunnel and VSBK, the firing zone remains fixed (Valette and Mitra, 2017).

(i) Continuous domed kilns, or Hoffman's kilns: Continuous domed kilns are also known as Hoffman's kilns. These types of industrial kiln used for firing bricks, tiles, and other ceramic products. These kilns were invented by German engineer Friedrich Hoffmann in the mid-19th century. Such kilns became popular in Europe and other areas in the following decades. A Hoffman's kiln consists of a long, narrow, and rectangular

chamber with a domed roof that slopes downward toward one end. The chamber is divided into several compartments or bays by low walls or setting walls. Each bay has a firebox at one end, where fuel (usually coal) is burned to heat the kiln, and a chimney at the other end, which allows hot gases to escape.

The process of firing ceramics or other material in a Hoffman's kiln is continuous, meaning that new products are added to one end of the kiln as finished products are removed from the other end. The process of firing in such types of kilns is very slow and takes several days, with the temperature gradually increasing from one end to the other. As the temperature rises, the products are moved from one bay to the next using a special device called a firing cart. One advantage of these kilns is their high fuel efficiency. The heat from the combustion gases is used to preheat the air for combustion, that reduce fuel consumption. Another advantage of these kilns arethat the kilns can be operated continuously, allowing for a steady production of ceramic products.

However, such types of kilns are relatively complex and expensive to build, and they require a significant amount of labor or employees to operate. In recent decades, many manufactures of brick and tile have switched to more modern and efficient kiln designs, such as roller kilns and tunnel kilns. Nevertheless, Hoffman's kilns are still in use across the world, especially in developing countries where labor costs are low and fuel supplies are limited.

(ii) Bull Trench Kiln (BTK): Bull Trench Kiln are used for firing bricks that is commonly found in South Asia, particularly in India, Pakistan, Sri lanka and Nepal. It is a continuous sloping kiln that is built into the ground, with a long, winding brick lined trench that serves as the firing chamber.

The Bull Trench Kiln was originally fired using bull dung as fuel, which is how it received its name. These days, though, other fuels including coal, wood, and agricultural waste are frequently utilized in its place. In the Bull Trench Kiln, the fire process is ongoing, with finished bricks being taken from one end of the kiln and new green bricks

being placed to the other. As the bricks go down the trench, their temperature rises progressively; near the conclusion of the fire operation, the bricks attain their greatest temperatures. The firing process typically takes several days to complete. While the Bull Trench Kiln is an efficient and cost-effective way of firing bricks, it is also associated with significant environmental and health problems. The use of high-polluting fuels and the large amounts of smoke and emissions generated by the kilns can lead to air pollution and respiratory problems for people living nearby. In recent years, efforts have been made to replace Bull Trench Kilns with cleaner and more efficient technological approaches, like Vertical Shaft Brick Kilns and Zigzag Kilns.

C. Zigzag Kiln - It is a type of brick kiln that is used for firing clay bricks. It is called a "zigzag" kiln because the bricks are stacked in a zigzag pattern inside the kiln. This design allows for more efficient use of fuel and results in lower emissions compared to traditional kilns. In a zigzag brick kiln, the fuel is typically burned in a central chamber, and the heat and gases are directed through a series of flues that zigzag through the stacked bricks. In this kiln, the bricks are arranged in such a way that forces the hot gases to flow back and forth through the kiln, allowing for more even heating and better fuel efficiency.

Compared to traditional kilns, zigzag kilns can reduce fuel consumption by up to 30%, and emissions of carbon monoxide and particulate matter by up to 50%. This makes them a more environmentally friendly option for brick production, and these types of kilns are being adopted in many countries of the world.

D. Tunnel Kiln -This type of kilns comes under continuous kilns, which are typically used for firing clay products such as bricks, tiles, and ceramics. The name "tunnel kiln" comes from the fact that the kiln is shaped like a tunnel, with a long, narrow chamber that extends from one end to the other. In a tunnel kiln, the products to be fired are loaded onto cars or trucks, which are then pushed through the kiln on rails. As the products move

through the kiln, they are gradually heated to the desired temperature, maintained at that temperature for a set period of time, and then cooled back down to room temperature.

Tunnel kilns are often used in large-scale industrial operations, where high volume production is required. In comparison to batch kilns, these are often more effective in terms of energy-consumption, since the heat from the firing process is retained within the kiln and used to preheat the incoming products. Tunnel kilns can also be used for a variety of different firing processes, including oxidizing, reducing, and neutral atmospheres. Overall, tunnel kilns are an important tool in the production of wide range of clay products, and because of their contributions, today's industrial ceramics are what they are.

E. Vertical Shaft Brick Kiln (VSBK) -It is an incessant, updraft firing kiln commonly used in developing countries for the production of tiles, bricks, and other ceramic products. The kiln consists of a tall vertical shaft with firing zones located at the bottom, middle, and top of the shaft. The process begins with green bricks being loaded into the kiln from the top, where they gradually move downward through the firing zones. In each zone, the bricks are exposed to increasing temperatures, with the highest temperatures reached in the bottom zone. The kiln is fired using a variety of fuels, including coal, wood, and agricultural waste, and the combustion gases flow upward through the firing zones, heating the bricks as they move downward. The firing process typically takes several days to complete, during which time the kiln is monitored and adjusted as necessary to ensure proper temperature and airflow. They are taken batch by batch from the bottom via an unloading tunnel after being fired in the shaft. It's a good fit for the situation (Maithel and Uma, 2012).VSBKs are known for their energy efficiency and low emissions compared to traditional brick kilns. They also require less capital investment and can be built using locally available materials, making them a popular choice in developing countries where resources may be limited. However, they do require a certain level of technical knowledge and training to operate effectively.

1.4. Process of Brick making

Over the decades and across geographies, the method of producing a brick has remained largely unchanged. The essential steps in the traditional brick-making process are outlined here.

a. Material Procurement

Material Procurement is a stage during which the clay is mined. Mostly clay is mined from agricultural land. Extracted clay is kept in open place. Clay get softens during this process and undesirable oxides also get removed.

Figure 1.2: Clay mining for material procurement.

(Source: Author's own)

b. Tempering

To get the ideal consistency, clay and water are hand blended during this process. In this process the clay is combined with water to achieve the desired consistency for molding. Hands and feet are used to manually mix the ingredients. Animal-powered pug mills are employed on occasion and in specific places.

Figure 1.3: Tempering of clay.

(Source: Author's own)

c. Molding

Figure 1.4: Molding of clay in metal mold.

(Source: Author's own)

The molding process is a critical step in the manufacture of bricks. It involves shaping the clay or other materials into the desired form and size before the bricks are fired. The clay is molded into the desired shape by using different types of clamps or techniques. The most common method is called the soft-mud process, in which the clay is molded into a rectangular shape using a wooden mold or a metal frame called a brick mold.

d. Drying

Figure 1.5: Drying of bricks in sunlight.

(Source: Author's own)

The drying process is a crucial step in brick making as it helps to remove excess moisture from the freshly molded bricks, which is essential for ensuring their strength and durability. The drying process typically involves two phases: the primary and the final drying phases. During the initial drying stage, also recognized as the "green" phases, the newly molded bricks are placed on aeration racks in a shaded area for a few hours to allow them to dry out slightly. This stage is critical for preventing cracks from forming in the bricks as they dry. After the initial drying stage, the bricks are moved to the final drying stage, which can take several days or even weeks, dependent on the size of the bricks and the weather situations. During this stage, the bricks are typically placed in direct sunlight or in a drying chamber with controlled temperature and humidity.

e. Firing

The firing stage is the main step in the brick making process. The temperature inside the kiln is increased to between 800-1200°C, based on the kind of bricks and the desired

Figure 1.6: Firing of bricks in Kiln.

(Source: Author's own)

properties. The firing process can take several days to complete, and the bricks are exposed to different temperature zones to achieve uniform heating and prevent cracking.

f. Sorting

The bricks are sorted by colour after the kiln has been disassembled. The level of burning is indicated by the colour. Over-baked bricks are infrequently used for paving and roofing the kiln, whereas slightly under-baked bricks are used to build interior walls or are re-baked in the subsequent kiln.

Figure 1.7: Sorting of bricks for supply

(Source: Author's own)

1.5 Brick Kiln industry in Punjab

As per Punjab Pollution Control Board circular (2022), there are around 2,800 brick kilns, 1000 of which have altered into Zigzag technology or are in the process of changing. This is a seasonal business for brick kiln owners or labour. Mostly brick kilns are located in rural areas of Punjab. Ludhiana district is on top list with 305 brick kilns out of 22 district of Punjab. While Sri Fatehgarh Sahib is on bottom with 50 brick kilns as per food and supply department list of brick kilns.

Table1.2: List of brick kilns in different districts of Punjab.

	Districts	**Brick Kilns**
1	Ludhiana	281
2	Bathinda	217

3	Sangrur	214
4	Amritsar	204
5	Jalandhar	187
6	Tarn Taran	153
7	Moga	151
8	Patiala	151
9	Gurdaspur	148
10	Fazilka	147
11	Mansa	141
12	Hoshiarpur	120
13	Sri Muktsar Sahib	113
14	S.A.S.Nagar	111
15	Ferozepur	102
16	Roopnagar	79
17	S.B.S. Nagar	69
18	Faridkot	67
19	Barnala	58
20	Pathankot	56
21	Kapurthala	54
22	F.G.Sahib	50

(Source: Food and supply department of Punjab)

In Punjab mostly brick kilns are operational in September to November and January to April month. Most of the brick kilns in Punjab were using FCBTK (Fixed Chimney Bull Trench Kiln) method. But after the notice, issued by Punjab Pollution Control Board on 28th may 2019, brick kilns started using Zigzag technology. Brick kilns in Punjab generate roughly 15-20 billion bricks annually, or about 8 percent of the nation's total production, according to the Punjab State Council of Technology.

1.6 Environment

As development is taking place, it is natural to have an impact on the environment. Environment is the colloquial term for everything that surrounds and influences an organism throughout the course of its lifetime. The linkage among the water, air and land, as well as with property, people, and other living things, is collectively referred to as the environment. It encompasses the entire physical and biological surrounding and their interactions (Fisher and Nasrin, 2021). Environmental studies are a way to learn more about the environment of our planet and how human life affects it. The environment is therefore a multidisciplinary subject that includes, among other fields, history, geology, geography, economics, geophysics, hydrology, biotechnology, soil science, remote sensing, physics and physiology.

1.6.1 Environmental Health

Health does not necessarily mean the absence of disability and illness. It is a condition of total mental, physical and well-being of social (WHO, 2022). According to the WHO, environmental health refers to the overall suitability of the environment in terms of habitat and people. A state of co-relationship exists between health and many aspects of urbanization, such as housing, work environment, quality of life, waste disposal system, and so forth. Environmental health also entails the preservation of an environment that provides mankind with comfort and efficient performance.

Furthermore, the rapid change in the human environment has exacerbated difficulties linked with urban population and development. The most important issues include slums, limited living space, and noise, and changes in the social environment have exacerbated poverty and trash disposal issues (Prasad and Sanyal, 2016).

1.6.2 Environmental Pollution

Environmental pollution is defined as a reduction in local environmental quality caused only by human activity. Geographers in general and environmental geographers in particular, look at pollution from a variety of perspectives. Pollution is unquestionably

the outcome of the urban-industrial technology-based revolution, including the voracious and speedy misuse of natural resources, greater rates of energy and matter exchange, and ever-increasing industrial waste, consumer products and, urban effluents (Sharan et al., 1996).

Dixon (1972) defined pollution as all intentional or unintentional human and domestic animal behavior, as well as the resulting effect, that interfere in any way, either temporarily or permanently, with a person's enjoyment of and ability to fully benefit from their environment. On the other hand, Nathanson (2023) has defined pollution as the accumulation of chemicals, or forms of energy, in the environment in quantities or at rates that surpass ecosystems' ability to neutralize or disperse them to safe levels.

Natural resources have been severely damaged as a result of modern man's relentless advancement. The dangers of environmental contamination must be more publicly understood. The United Nations Conference on Environment and Development and the Earth Summit on Sustainable Development, organized in Rio de Janeiro, have brought attention to the environment's decline and increased public awareness of global environmental issues.

1.6.3 Environmental Pollutant

Any form of energy or substance that degrades or pollutes the natural equilibrium of ecosystems is referred to as a pollutant. Pollutants are split into two categories based on their source or genesis: natural pollutants and man-made pollutants. Pollutants are further categorized into visible and invisible pollutants based on their visibility. Solid particulate pollutants include industrial waste such as lead, tailings, mercury, asbestos, aerosols, etc., gaseous pollutants include chlorofluorocarbon gases, Sulphur Dioxide, Carbon Dioxide, Nitrogen Oxide, and others, and liquid pollutants include dissolved solids, leaked oil slicks in sea water, Urea, Ammonia, Nitrate, Fluoride, Carbonates, Chloride, insecticides and pesticides in dissolved form, greases and oil etc. (Zannetti and Daly, 2007). Pollutants may also be categorized according to the area polluted by specific pollutant

and group of pollutants such as air pollutants e.g. sulphur, carbon dioxide, nitrogen oxide, hydrocarbon, ammonia, lead, carbon monoxide, aerosols, aldehydes, asbestos, etc., water pollutants e.g. dissolve and suspended solids, Calcium and bicarbonate ions, Chlorine ion, Sodium ion, Sulphate ion, Nitrate ion, Magnesium ion, Potassium ion, insecticide and pesticide residues, toxic metals such as Lead, Mercury and Cadmium, radioactive waste etc. and land pollutants such as human and animal waste/excreta, pesticides, garbage, insecticides and chemical fertilizers, machines and tools radioactive substances etc. (Prasad and Sanyal, 2014).

1.6.4Brick kiln and the environment

One of the smaller-scale industries is brick-making that pollutes air, water, and land, according to the Central Pollution Control Board (CPCB, 2016). Over 10 million migrant workers are hired in the labor-intensive brick kiln sector in India. Regarding furnace design, fuel type, workplace safety precautions, etc., the industry is not specifically governed by any legislative regulations (S. Tandon, S. Gupta, et al., 2017). Because of this, a lot of brick kilns use a range of useable materials as fuel, including plastic, rubber, old tyres, recycled motor oil etc. cause large amounts of toxic gases to be emitted from the furnaces of 7 kilns, for example nitrogen oxide (NO_x),carbon dioxide (CO2), carbon monoxide (CO),hydrogen sulfide (H_2S), suspended particulate matters and lot of carcinogenic dioxins. All these gases are polluting environment. The brick kilns are considered as the primary sources of pollutants that deplete the ozone layer and create acid rain. When atmospheric pollutants come into contact with rainfall, they are transformed into weak acids which are able to eat away at leaves of plants and stems as well as animals' skin. Whenever all these destructive gases move into a river or ocean with water, they can harm aquatic life. Additionally, the earth absorbs these chemicals, changing the soil's PH (Fatima et al., 2011).

According to Pokhrel and Lee (2011), air pollution has both long-term and immediate impacts. The immediate effects include poor fruit and vegetable development, while the long-term effects include groundwater level decline, ozone layer destruction, and

deforestation (Khan et al., 2019).Clay is overused in bricks, which degrades the land and leads to a number of environmental issues (Khan and Vyas, 2008). Coal is the rudimentary fuel utilized in these furnaces. Deforestation caused by the excessive use of wood to supply coal to brick kilns results in a number of problems, as well as soil erosion, air pollution, diseases linked to it, and climate alteration. It is believed that brick kilns exert has a negative impact on human health. When inhaled by people, dangerous gases like CO, CO2, SO2, PM, and NOx can lead to nervous system, cardiovascular, and different respiratory illnesses. Lung cancer, emphysema, asthma, serious bronchitis, coughing up saliva, lightheadedness and wheezing are some respiratory conditions that can be brought on by leaving brick kilns. The release of harmful gases also contributes to other health problems, such as eye, nasal, and tongue irritation, in addition to respiratory illnesses (Skinder et al., 2014a, 2014b).

1.6.5 Land Degradation

Figure 1.8: Mining of agriculture land in Roopnagar.

(Source: Author's own)

The key components of environment which are being affected by the brick industries are not limited to soil, air, water etc. Mainly bricks are made of soil and excessive use of soil causes soil degradation. The underlying shape of the land is damaged due to, brick making and firing. Brick production and burning have altered the land's underlying form. The inefficient uses of a large amount of fuel and the kiln process results in pollution and harm to vegetation and human health.

The organization of productive topsoil is disrupted by land degradation, which also affects soil assets (2003, Yadav et al.). The efficiency and productivity of land deteriorates as a result of urban sprawl and economic development. Soil resources will be strained as the global population grows. Land degradation can be defined as the loss of actual or potential production or utility due to natural or human-made forces (Eswaran,

1999). The hazardous compounds released by these brick kilns have an adverse and negative effect on the soil, amenity, vegetation, and legacy in the area. Animals and people living in neighboring areas are also harmed, with women, children, and brick workers suffering the most (Bhanarkar et al., 2002). On the other hand, as a result of the agricultural land's top soil layer degrading, eroded dirt eventually enters the nearby aquatic system through various catchment channels. By virtue of its biological, chemical, and physical properties, water reflects its sustenance quality and ecological potential. Today's increase in anthropogenic effects in and near the catchment region of aquatic systems results in a significant amount of nutrient enrichment in the aquatic systems, which worsens water quality. The ecological and physicochemical characteristics of aquatic systems are significantly impacted by the brick industry.

Figure 1.9: Mining of agriculture land in Roopnagar.

(Source: Author's own)

1.7Action taken by CPCB and PPCB

In an effort to lessen the environmental pollution that brick kilns cause, the Central Pollution Control Board (CPCB) issued an order on June 27, 2017, mandating that all kilns in the country implement a rectangular kiln-shaped draught technique that was influenced by Zigzag brick setting. However, this order made no mention of a conversion date of any kind. The PPCB (Punjab Pollution Control Board) resolved to only permit operation of kilns with new technology after March 31, 2019, in accordance with the directives of the CPCB. After this, Punjab Government permitted brick entrepreneurs to continue using FCBTK for another 6 months by extending time limit. Despite this Punjab pollution control board decision, the National Green Tribunal (NGT) issued an order on

October 24, 2018 stating that brick kilns using new technology will be permitted to operate after January 31, 2019.As per the Times of India report (October 4, 2019), during process of conversion of brick kiln into new technology the kilns have to pay environmental compensation to the Punjab Pollution Control Board (PPCB) on the basis of 'Pollutant Payment Principles'. For kilns with a production potential of more than 30,000 bricks per day, compensation has been set at Rs. 25,000 per month, and for kilns with a production capacity of less than 30thousand bricks per day, it has been set at Rs. 20,000 per month. Time to time improvement is going in brick kiln technology. Government is trying to control brick kiln pollution. In this context government is planning to convert all brick kilns from coal to CNG. PPCB (Punjab Pollution Control Board), CPCB (Central Pollution Control Board) and NGT (National Green Tribunal)have full attention towards brick kiln industry. Time to time circular and notices are issued to brick kiln owners to control pollution.

1.8 Green practices

Green practices in industry and organizations refer to the adoption of environmentally sustainable methods and techniques in their operations. The main aim of these practices is to reduce the negative impact of industrial and organizational activities on the environment and promote a more sustainable approach to resource use.

Here are some examples of green practices in industry and organizations:

- **Energy conservation:** Using energy-saving techniques, such as installing solar panels, converting to LED lighting, using energy-efficient equipment, and turning off lights and devices when not in use, may all help reduce energy use.
- **Waste reduction:** Implementing waste reduction practices such as reducing paper usage, recycling materials, and reusing products or materials.
- **Water conservation:** Using water-saving techniques including rainwater collection, low-flow fixtures, and water use reduction.

- **Sustainable transportation:** Encouraging the use of public transportation, biking, carpooling, or walking to work to reduce emissions.
- **Green procurement:** Purchasing products that are eco-friendly, sustainable, and ethically sourced.
- **Sustainable sourcing:** Sourcing raw materials from sustainable sources that are eco-friendly and have minimal negative impact on the environment.
- **Carbon footprint reduction:** Adopting practices that reduce greenhouse gas emissions such as lowering energy needs while increasing interest in renewable power.
- **Sustainable packaging:** Using packaging materials that are biodegradable, recyclable, and made from eco-friendly materials.

Green practices may help businesses and organizations embrace a more sustainable future by reducing the negative environmental effects of their operations.

Sustainable asset management and environmental pollution are now significant global issues due to a lack of resources and environmental concerns. It's possible that the growth of the economy as a whole and efforts to reduce pollution and handle resources sustainably do not work simultaneously (Wang et al., 2014). Eco-friendly expert acts with significant financial implications are necessary as organizations struggle to find a middle ground between heavy resource utilization and the expansion of financial relics (Chan et al., 2007). Numerous businesses are compelled to engage in operations that improve economic value (Kramer and Porter, 2019).

The overexploitation of natural resources is one of the many ecological concerns brought on by the accelerated expansion of the economy (Gibson and Atlin, 2017). Numerous nations have set up organizations and laws to protect the environment and promote environmental sustainability (Weng et al., 2015).According to environmental supervisors, such rule and regulation impositions have attracted their notice (Claver et al., 2007; Zhu and Sarkis, 2004).They also have the same effects of changing

supervision and rivalry practices between organizations. Organizations have been forced to adopt eco-friendly practices in order to follow the new environmental regulations, have a favorable brand image (Hillestad et al., 2010; Chen, 2008a, 2010), better performance of the companies, and gain a superiority over the competition (Claver et al., 2007; Rusinko, 2007).

Many studies inspected aspects that might affect supply chain laws, ethical standards, and regulatory frameworks, as well as green innovations (GI) practices (Chen and Feng, 2018; Singh and El-Kassar, 2019; Gao and Ahmad, 2018). Increasing stakeholder pressure, public awareness, and shareholder weight associated to green environmental challenges have also been studied in research (Foo, 2018). Additionally, research indicates that the public, clients, and federal organizations are placing a greater demand on GI practitioners. Nevertheless, the research on the correlation between stakeholder demand and organizational outcomes is lacking. Some of the examples are pressure from the government and rivals, as well as GI practices and employee conduct (EC). The production or manufacturing industry is under more shareholder burden because it likely generates the most trash (Chen, 2008b' Chang, 2011).

Businesses primarily use the "go-green" movement to address environmental problems. The management sciences field has studied and debated strategies for fostering green competencies and new eco-friendly behaviors over time (Ullah, 2017). In order to make it easy for accepting GI, businesses are obliged to reflection the crucial traits as well as the predecessors in the business entities (Arfi et al., 2018). Consumer concerns (Zhu et al., 2017), qualifications of suppliers and partners (Chiou et al., 2011), preferences of owners and professionals (Huang et al., 2009), rules and regulations of governing bodies (Kammerer, 2009), organizational and environmental, and technological aspects of green innovation practices are a few of these (Ho and Lin, 2011).

1.8.1 Green Practices in brick kiln Industry

The brick kiln industry is known to have a note worthy effect on the environment due to its consumption of high energy and emission of greenhouse gases. However, there are several green practices that can be implemented in the brick kiln industry to reduce its environmental impact. Here are some examples:

- **Use of cleaner fuels:** Traditional brick kilns use fossil fuels such as coal or wood as a source of heat. However, using greener fuels, like liquefied petroleum gas (LPG) or natural gas can significantly reduce emissions of greenhouse gases and air pollutants.
- **Adoption of energy-efficient technologies:** Energy consumption may be decreased and the total efficiency of the brick-making process can be increased with the use of contemporary brick kilns outfitted with energy-efficient technology including heat recovery systems, heat exchangers, and enhanced insulation.
- **Recycling and reuse of waste materials:** Brick kiln waste materials such as broken bricks, tiles, and other construction debris can be recycled and reused in process of brick-making. By doing this, waste production is decreased and natural resource conservation is aided.
- **Use of renewable energy sources:** Kilns for making bricks can be fueled by environmentally friendly power sources including solar energy, wind energy, or even biogas. This helps reduces greenhouse gas emissions and reduce reliance on fossil fuels.
- **Proper maintenance and cleaning of equipment:** Regular maintenance and cleaning of brick kiln equipment can help improve efficiency and reduce emissions of pollutants.
- **Training and awareness-raising:** Providing training and awareness-raising programs to workers in the brick kiln industry can help promote environmentally friendly practices and reduce the industry's environmental impact.

1.9 Green technologies

I. **Zig-zag Technology:** The Zig-zag brick kiln technology is an improved method of brick production that is more environmentally friendly and energy-efficient than traditional kilns. The Swiss Agency for Development and Cooperation, in conjunction with the Ministry of Environment, Science, and Technology of Nepal, created the technology in the 1980s, and a number of nations have since embraced it. In traditional brick kilns, bricks are fired using a continuous firing process that consumes a large amount of energy and emits significant amounts of pollutants into the environment. The Zig-zag brick kiln technology, on the other hand, uses a Zig-zag arrangement of bricks inside the kiln that allows for better heat transfer and combustion efficiency. The bricks are arranged in a Zig-zag pattern, which creates a tortuous path for the flue gases to travel through the kiln, resulting in longer residence time and higher heat transfer. The technology is also designed with an improved air supply system that ensures more complete combustion of the fuel, reducing the amount of emissions produced. The kiln's design also allows for easy and efficient recovery of waste heat, which can be used for drying and other processes, further reducing energy consumption. Zigzag brick kilns have been shown to reduce fuel consumption by up to 30% compared to traditional kilns and significantly reduce emissions of pollutants such as sulfur dioxide, particulate matter, and carbon monoxide. They also produce higher quality bricks due to the more consistent firing temperatures and reduce the need for manual labor in the production process. Overall, the Zig-zag brick kiln technology is a promising solution for reducing the environmental impact of brick

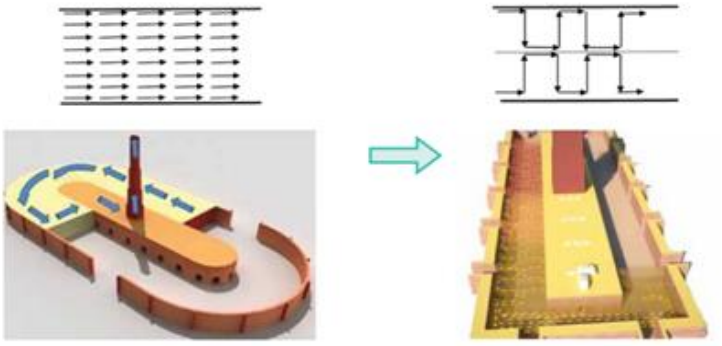

Figure 1.10: Conversion of FCBTK into Zigzag. *(Source: Internet)*

production and improving the quality and efficiency of brick manufacturing. Bricks are stacked in zigzag kilns so that hot air may go through them. The length of zigzag air path is around three times greater than that of a straight line, which enhances the efficiency of the entire process by improving the heat transmission from the fuel gases to the bricks.

II. **Use of Natural Gas:** While the consumption of coal is reduced by the use of natural gas, it does not have any adverse effect on the environment. Natural gas is supplied to raw bricks through pipes. Its use is also very beneficial for the coal workers because by putting coal in the bricks, they get many diseases. In such a situation, supplying gas does not have any adverse effect on their health. Natural gas can be used as a fuel source in brick kilns, replacing traditional fuels such as coal or wood. This can offer several advantages, including:

Figure 1.11: Use of natural gas in a Hoffman kiln in Bangladesh. *(Source: GKSPL)*

- Improved efficiency: Natural gas burns more cleanly and efficiently than coal or wood, resulting in a reduction in fuel consumption and improved energy efficiency.
- Reduced emissions: Greenhouse gas emissions and other air pollutants may be significantly reduced by using natural gas in brick kilns, creating a healthier and cleaner atmosphere.

- Cost savings: While the initial investment in converting to natural gas may be significant, in the long term, it can offer cost savings through reduced fuel consumption and maintenance costs.

- Consistent heat: Natural gas can provide a more consistent heat source compared to traditional fuels, resulting in a more even firing process and improved quality of the finished bricks.

However, it is a noteworthy point that the use of natural gas in brick kilns is not without its challenges. These include the initial investment required to convert to natural gas, the need for proper infrastructure and equipment to handle the fuel, and potential safety risks associated with the use of natural gas. Additionally, it is important to ensure that natural gas is sourced responsibly and that proper measures are in place to prevent leaks and other accidents.

III. **Coal and biogas feeder:** Coal and biogas feeder consisting of a coal crusher and delivery unit. Occasionally firemen physically feed coal or fuel into the existing FCBTK, Hoffmann, and Zigzag kilns. Coal is often placed into feeding holes using a spoon or bucket one or two firemen will feed coal at a time. Typically, coal is not continuously fed; it is fed for about 10-15 minutes, then there is a non-feeding period of 15 to 20 minutes, and then the coal/fuel feeding is repeated. It is evident that burning stored fuel results in sporadic increases in carbon dioxide and carbon monoxide concentrations. After the accumulated coal is burned, concentration levels restore to their initial values. PM emissions are predicted to follow similar trends. The findings demonstrate that by guaranteeing cleaner combustion, continuous feeding of appropriately proportioned fuel into Zigzag kilns will reduce both coal usage and emissions. Solid fuel burners or various forms of mechanical coal stoking systems can be used. A fuel crushing and distribution

Figure 1.12: Use of natural gas in a Hoffman kiln in Bangladesh. *(Source: GKSPL)*

mechanism that distributes solid fuel combined with positive airflow to solid fuel burners of specific and ensures flawless and consistent firing. A trickling feeder used to feed biomass fuel into a Hoffmann kiln used to fire clay tiles in Balaghat, Madhya Pradesh.

Mechanized coal feeding systems may greatly improve working conditions for firemen while also reducing air pollution from brick kilns. To feed fuel into the kiln, firemen currently walk on the surface while being exposed to temperatures between 80 °C and 120 °C. Due to the lack of a permanent roof, zigzag kilns and FCBTKs provide some unique issues for feeder use.

Figure 1.13: Trickle feeder for feeding biomass fuel in kiln. *(Source: GKSPL)*

IV. **Brick making machine:** A brick making machine is a mechanical device used to make bricks from raw materials such as cement, clay, sand, and water.

Figure 1.14: Brick making machine. *(Source: Internet)*

The machine typically consists of a mixing chamber, a molding chamber, and a kiln where the bricks are dried and hardened. There are several types of brick making machines available, ranging from manual to fully automated systems. Manual machines require human labor to mix and mold the raw materials, while automated machines can perform these tasks automatically

with little or no human intervention. The basic process of making bricks using a brick making machine involves mixing the raw materials in the mixing chamber, molding the blend into the anticipated form in the molding chamber, and then drying and hardening the bricks in the kiln. The finished bricks can then be removed from the machine and used for construction. In the construction business, brick-making machines are widely utilized, particularly in developing nations where labour costs are cheap and there is a significant need for affordable building materials.

They offer a cost-effective and efficient way to produce large quantities of bricks quickly and easily. A brick machine is a device that uses a press to compress clay into the shape of bricks. Because you can use them to create any type of brick you desire, they are highly adaptable. Due to the fact that brick machines don't require gasoline to run, they are more environmentally friendly and long-lasting. In India there are lots of companies which are making brick machines.

V. ***Desi Jugaad*:** Sometimes for lack of money or for convenience, people create a new technology with the combination of many machines, which is called *Jugaad*. In every sector these *jugaads* are in working. In brick industry different types of *Jugaads* are available. Some operated by generators and some are operated by tractors or other engines. "*Desi jugad*" is a term commonly used in India to refer to resourceful and improvised solutions to problems. In the context of a brick kiln, there are several desi jugad techniques that workers may use to make their work easier or more efficient.

Here are a few examples:

- Using discarded oil drums as chimneys: Brick kilns generate a lot of smoke and soot, which can be harmful to workers' health. To reduce the amount of smoke in the work area, workers may use **discarded** oil drums as makeshift chimneys. These drums can be cut in half and placed on top of the kiln, allowing the smoke to escape into the open air.

- Using leftover ash of thermal plants as a building material: Thermal plantsand brick kilns generate a lot of ash as a byproduct of the firing process. This ash can be mixed with other materials, such as mud or cement, to create a building material that is inexpensive and durable. Using bicycles to transport materials:
- Brick kilns require a lot of manual labor to move materials around the site. To make this process easier, workers may use bicycles to transport materials such as bricks, clay, or water. By attaching baskets or trailers to their bicycles, workers can carry more weight and move more quickly than they would on foot.
- Brick making machines can be manual or motorized. Manual brick making machines require physical effort to produce bricks, while motorized brick making machines use a motor to power the brick making process. In this type Jugaad clamps are attached to electric motors.

Figure 1.15: Brick making machines (Jugaads). *(Source: Internet)*

- Using cow dung as fuel: In some parts of India, cow dung is a commonly used fuel source. Workers at brick kilns may collect cow dung from nearby villages and use it to fuel their kilns. This can be a more sustainable and cost-effective alternative to traditional fuels such as wood or coal.

- Before clay was tempered by food or hand. Now a days different types are machines available in the market Except this people used desi jugaad to temper clay. A pug mill is a machine used in pottery and ceramics for mixing, kneading, and tempering clay. The machine consists of a large cylindrical barrel, which may be made of stainless steel or other materials, and one or more mixing blades or augers. To use a pug mill for temperingclay. In this process the clay is first mixed with water to make it more pliable. The mixture is then fed into the pug mill through a hopper at the top. As the mixture is pushed through the barrel by the mixing blades, it is kneaded and blended together to form a smooth, consistent clay body.These are just a few examples of desi jugad techniques that workers at brick kilns may use. While these solutions may not be perfect or ideal, they demonstrate a resourcefulness and ingenuity that is characteristic of many workers in India.

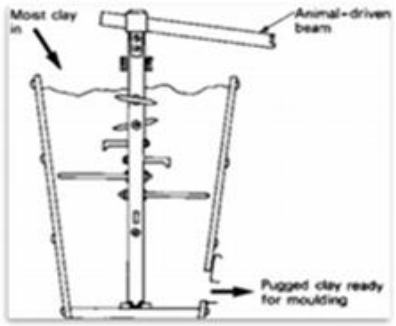

Figure 1.16: Pug Mil. *(Source: Internet)*

1.10Overall view of problem

Pollutants released by brick kilns include carbon monoxide, sulphur dioxide, nitrogen oxides, and particulate matter. These pollutants add to air pollution, which can affect the health of neighboring people by causing respiratory disorders and other difficulties. Because traditional brick kilns need a lot of wood fuel to fire bricks, there is a loss of habitat and deforestation. Aside from this in order to make bricks, soil must frequently be excavated in brick kiln operations, which causes soil erosion and deterioration. Land fertility and agricultural output may suffer as a result. In Punjab, brick kilns are on conversion stage into Zzk (Zigzag Kiln). Not only Zzk, there are number of technologies, that can reduce emission of pollutants into atmosphere. This research study will help in what factors initiate the adoption of green technologies in brick kiln sector, and are the obstacles in adoption of green technologies.

1.11 Theoretical framework

In this research study, the Unified Theory of Acceptance and Use of Technology (UTAUT) model of Venkatesh, Davis, and Morris (2003) is utilized to analyze the adoption of environmentally friendly technologies in Punjab's brick kiln sector. This entails determining the ways in which different factors impact the uptake and utilization of eco-friendly technologies. In this research study,schedule is applied for collection of data from different brick kilns sites of Punjab. In schedule, questions related to performance expectancy, effort expectancy, social influence and facilitating conditions are adapted from related studies of UTAUT model (Venkatesh et al., 2003). Further, apart from considering all the moderators of UTAUT model, namely experience, voluntariness of use and age, this study also analyses the moderating effect of education and firm size as well.

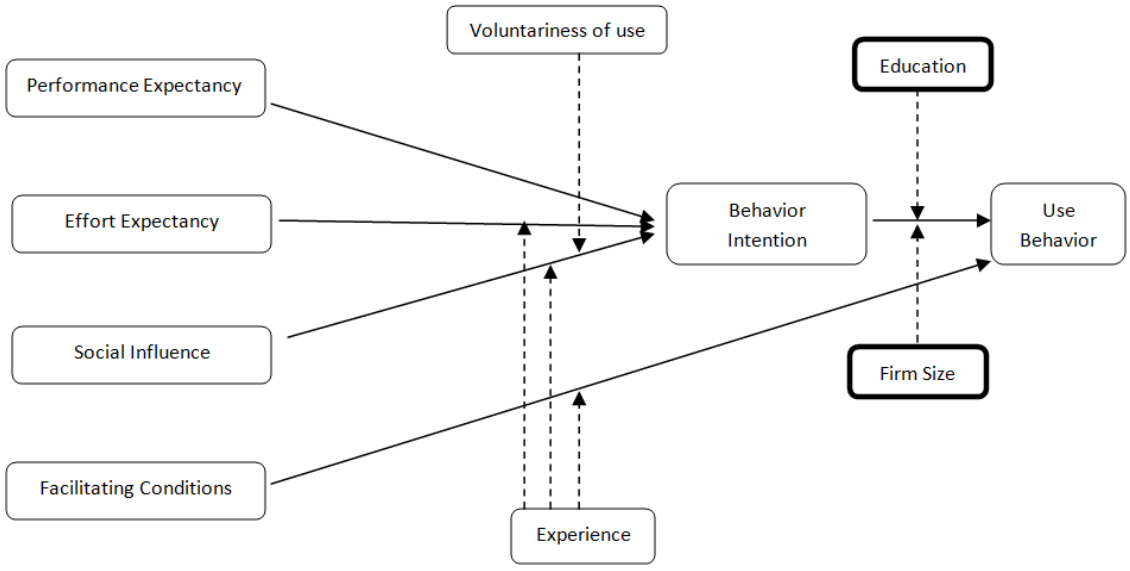

Figure 1.17: Theoretical framework

1.11.1 Constructs of UTAUT model and their adaption in green technology adoption

Performance Expectancy (PE): Researcher has endeavored to investigate the ways in which integrating green technology into brick kilns might result in advantages including diminished ecological footprints, adherence to rules and regulations, and even financial savings via energy conservation.

Effort Expectancy (EE): This research study will explore the perceived ease or difficulty of implementing green technology solutions in brick kilns.

Social Influence (SI): Researchers have attempted to investigate the impact of social variables, such as peer pressure, government backing, industrial associations' or environmental groups' support, etc., on the adoption of green technology.

Facilitating Conditions (FC): The availability of infrastructure, resources, and other variables has been identified as the primary drivers behind the development of green technology in the brick kiln sector.

CHAPTER-2

LITERATURE REVIEW

A close look at the study of published scholarly literature on a specific topic or research question is called literature review. It involves examining, evaluating, and synthesizing previous research in the field, to identify gaps in knowledge, to suggest new research questions or directions, and to provide a context for the current study. A literature review typically includes an overview of the key concepts, theories, and findings in the field, as well as a discussion of the strengths and weaknesses of previous studies, and a summary of the current state of knowledge. The construction or development of a theoretical or conceptual framework is aided by a literature review. The literature pertinent to the specific issues or subject is discussed against a conceptual or theoretical framework. The most important discoveries, methodological concerns, and relevant findings from earlier and more recent studies are discussed. Moreover, the logical connection between previous and more modern works is made clear field, and disputed issues are covered when necessary.

The researcher's theoretical framework and hypothesis are both developed with the aid of a literature survey. It becomes acquainted with the pertinent knowledge-related issue that must be resolved. Also, it enables the researcher to approach an issue from a certain perspective, which undoubtedly shapes and generates a wealth of insightful ideas on the subject of the study. Using secondary data sources, a methodical procedure is employed to find published and unpublished work on the subject of interest.. The literature review, which also includes the identification, definition, and justification of the pertinent concepts connected to the subject, provides the researcher with a framework for the research.It enables the researcher to support a conceptual model's links between the variables with evidence. Such a good literary analysis serves as the basis for creating a wide hypothetical framework from which concepts can be developed and put to the test. A thorough understanding of the research techniques that other researchers have employed to address their research question is given to the researchers through a

literature study. The researcher can reproduce methods by having knowledge of the ones that were employed, which will save time and effort. Research is aided by relating findings from other studies and placing them within a larger academic discussion.In the context of green technology adoption in brick kiln firms of Punjab, the current research evaluation clearly links several UTAUT model aspects. To learn more about the specific topic, the most pertinent articles as well as various types of information from research, books, journals, reports, business newspapers, etc., were employed.

2.1 Chronicle review on brick industry in India

In 1954, Chopra and Patwardan discussed the characteristics, raw material sources, mode of production, and cost structure of the brick industry. In connection with the labor-intensive processes and high brick production costs in Clamp and Bull trench kilns, the investigation revealed the unique characteristics of each brick firm. The cost of producing bricks is influenced by the clay's origin, accessibility, productivity, the pay of the labor force, and fuel prices. The book "Modern Brick Making" (1877-1967) by Searie Alfred explains the development of brick making. Egypt was the birthplace of brick making, and as the Roman Empire grew, brick making spread throughout Europe.

In his 1958 book "The Cultural Heritage of India," Radhakrishnan Sarvepalli outlined the importance of the brick industry in creating jobs, particularly for rural landless laborers. They can employ laborers from rural and underdeveloped areas due to the low level of mechanization in the brick-making process. Although the report emphasizes the industry's ability to create jobs, it leaves out any information regarding pay, working conditions, job security, etc. In the Ghazipur area (Lucknow), Aggarwal (1959) examined the socioeconomic circumstances of brick kiln laborers and discovered that this industry employs molders and loaders who are semiskilled and unskilled. The majority of the employed laborers belonged to the social underclass. Poor pay and accommodations facilities combine with exceedingly terrible working conditions. The study shows that brick industry laborers do not maintain a high quality of living. Yet, the study did not offer any suitable solutions to the issues the laborers were having.

The main issues facing India's brick and tile sector were examined by Jain and Jain in 1969. They discovered that the main issues facing the brick sector are production, price volatility, and product quality, whereas the main issues facing the tile industry are cracks and warps, rough appearance, curved alignment, air bubbles, blocked holes, etc. Brick production has evolved since the beginning of civilized man, according to Encyclopaedia Britannica (1971). About 6000 years ago, bricks were made in ancient Egypt, and they were sun-dried. The processes eventually included glazing, enameling, and burning. Ancient Babylon also embraced these practices. The primary source of raw materials for producing bricks was the riverbanks that laid the foundation for civilization.

Brick was the foundation of the Indus Valley Civilization, according to discoveries at the historic sites of Harappa and Mohenjo-Daro. The skill of manufacturing bricks was first practiced in Britain around 44 A.D.; hot climates with infrequent rainfall were the chosen locations. The Elizabethan age saw a boom in the brick business. Beginning in 1612, the American colonies supplied the necessary raw materials for the manufacture of bricks. In his book "Treasure of the Earth: Minerals," Krishna Swamy (1971), stated that residual or sedimentary clay was used to make bricks.

In his article "Clay Reserves in Kerala," published in 1973, Ayyappan Nair warned that the availability of clay deposits is rapidly diminishing, posing a severe challenge to the future of clay-dependent businesses like bricks, pottery, tiles, and so on. In his paper "Brick-Kiln employees in Greater Bangalore," Patil (1975), claimed that brick kiln workers in Bangalore are a form of "forced labor" because of their unstructured character, long hours of work without breaks or holidays, and extremely low wages. The brick kiln workers have similarly received little attention from the trade unions.In its analysis of the bricks market in 1978, the United Nations Industrial Development Organization paid special attention to the differences between bricks made by hand and by machine. According to the survey, bricks made by machine and by hand are in strong competition in developing countries. Bricks created by hand cost 29% less than bricks made by machine of the same size. The research looked at all the factors regarding the function of

middlemen who market handmade bricks in developing countries and whose influence causes a sizable difference between the "at kiln price" and the “delivered price" of handmade bricks. However, the analysis did not account for seasonal variations in brick costs.

Hiralal and Manjumar (1979) found that machine-made bricks are more economical than traditional hand-molded bricks in their study on modular bricks. The authors observed that, despite the fact that hand-molded bricks required a lot of labour and provided employment for many people, their quality lagged below that of machine-molded bricks.

Amiya Rao (1981) investigated the at work and accomodation circumstances of the laborers hired in the Haryana and Delhi brick kilns. He made mention of the appalling living conditions that brick kiln workers endure. They were rarely paid fairly, and child labor was widespread in the sector. The workers were disorganized, illiterate, uneducated, and uninformed of their basic rights. They had tuberculosis as a result of the unsanitary conditions in kilns. In their essay "Non-Application of Labour Regulations in Brick Kiln in Gujarat" from 1983, Randeria and Yagnik noted the causes of the laborers' disorganization. The dispersed brick kilns and migrant laborers with different linguistic backgrounds are blamed by the authors for their disorderly nature. The study only considers the issues; it makes no mention of any advantages that the workers might have.

Delhi in 1983, Puri (1983) evaluated the situation of manufacturers and workers in his paper. He stated in his report that the employees and producers were dissatisfied with their circumstances. Although owners sought government assistance in the form of credit facilities, a decrease in the cost of raw materials, and a fair price for bricks, workers urged for the appropriate application of labor regulations. Yet, the report makes no recommendations for how to strike a balance between the owners and employees of the brick sector.

In order to comprehend the effects of brick and tile clay mining on the fertility and agricultural activities of the corresponding areas, the KSLUB (Kerala State Land Use

Board) (1981) conducted a detailed survey in the Thrissur and Thiruvananthapuram districts. The survey's findings indicated that because there was very little mining, there were no major problems caused by it.

In their article "Employment generating brick kiln industry," Pandey, Prakash, and Sarup (1985) looked at the volume and structure of employment generated in the sector. The brick business provides skilled, semi-skilled, and unskilled people with around 120–150 days of employment per year. Yet, the study was unable to fully analyze the workers' pay structures. In his book "How to Decrease Energy Usage in Factories?", Vasan (1989), discovered that 8 percent of the components that make up the selling price of bricks are related to power costs. Additionally, he emphasized that each ton of bricks needs between 393.68 and 7871.36 units of electricity to be fired electrically. However, the majority of brick builders eschew electrical firing in favor of burning firewood, charcoal, or other locally accessible natural fuels instead, which severely degrades the environment.

The book "A Rudimentary Treatise on the Production of Bricks and Tiles" by Edward Dobson, published in 1889, is regarded as the pioneering work on brick making. He went into great length on the importance of tiles in ancient times and how they were a crucial component of monuments and other historic structures all across the world. Also, the publication provides a thorough account of various ancient designs. Mathur (1990) conducted research on the brick industry's potential for employment. Sadly, the majority of workers are semi-skilled and unskilled despite the fact that it is a labor-intensive business. Thus, the author has discussed the need of workforce planning in brick kilns.

At Thovalai Taluk, Kanyakumari District, Tamil Nadu, Dharam Lingam (1995) conducted research on the economic benefits of brick factories. The author analyzed the cost structure, fixed capital, working capital, pay rate, employment situation, marketing tactics, sales promotion strategy, etc. of the research area in order to interpret the economic features of the brick industry. According to Chavan-Upadhye (1991), the socioeconomic circumstances of migrant laborers were extremely precarious in his known article "A Socio-Economic Study of Immigrant Labour in Brick Making

Industries in the Sangli District." He emphasized the destitution, debt, illiteracy, horrible living conditions, and unemployment of the brick kiln employees, but the report offers no effective solutions to address these issues.

Aslam (1993) made several recommendations for the ecological conservation of the brick industry in his article titled, "Environmental Concerns in Brick Industry," including the implementation of more fuel-efficient technology, utilization of renewable resources, restoration of excavated lands, adoption of cutting-edge technologies, and insistence that they take a firm hold on the preservation of the environment.

In his 1998 study, Manoharan (1998) focused on the districts of Chengalpattu and Dharmapuri to investigate the size, sophistication, and competency of the brick industries in Tamil Nadu. He demonstrated that the size of the unit and the technology utilized, operational efficiency, and economies of scale in production are closely related. This study establishes the fact that if a unit is large, current technology can automatically be applied, leading to an increase in production and an improvement in technical and economic efficiency. However, the study did not examine the surroundings and working circumstances of laborers generally, let alone the marketing challenges the brick business was facing.

Despite this, the brick kiln sector pays taxes to the government in the form of sales taxes, income taxes, license fees, and local body taxes, including professional taxes. Nagarajan (1999) discovered that the administrators had disregarded the issues the sector was facing. He recommended that the government take decisive action to upgrade the sector in order to boost returns for both the government and firms.

According to Andrew Miller's essay from 2000, "Making of Fired Bricks in Tamil Nadu," the state of Tamil Nadu has a long history of using burnt bricks as the main building material. The author goes into more detail about the production of burnt bricks, including their composition, texture, qualities, and advantages over unfired bricks. He added that the brick industry exemplifies the characteristics of a small-scale, employing ten to thirty

workers industry. Out of 547 brick kilns located in the five districts of the Hissar division of the state of Haryana, 54 were chosen at random by Daram Pal Singh in his 2003 study, "Living Conditions of Women in Brick Kiln Industry of India: Reflecting the Agenda for Social Work Intervention."

The variables of education, wage, housing, health, safety, and welfare amenities of women employees were taken for analysis in order to determine the living conditions of female workers. According to the study, female workers' living conditions are unsatisfactory, and the author has advised brick kiln business owners to take sufficient safety and welfare measures for their female employees. Research on "Informal labor in Brick Kilns, Necessity for Legislation" was conducted by Jayoti Gupta in 2003. The author claims that brick kilns in Ghaziabad (Uttar Pradesh) and Faridabad (Haryana) operate primarily unrestrictedly without the necessary license or approval from relevant authorities. The owners and contractors also take advantage of workers who are paid insufficient wages. The success of the manufacturing sector, which consists of brick-and-mortar industries, has been an exciting aspect of economic growth, according to Pant (2004), a former deputy chairman of the Planning Commission. The manufacturing sector is growing quickly as a result of increased urbanization, industrialization, and related activities, which gives us confidence in this sector's capacity to serve as a growth engine.

Ruma Ghosh (2005) examined many facets of brick kiln employees in his study. The study underlined that a sizable workforce from rural and semi-rural areas is employed by the brick manufacturing business. Nonetheless, the business falls well short of other unorganized sector industries in terms of employment quality. Low salaries, seasonal employment, child labor, unhealthy working conditions, a lack of coordination, etc. are some of the major issues that workers confront, and these are highlighted in the report. In their study "Pull and Push Factors in Labor Migration: A Study of Brick Kiln Workers in Punjab," Naresh Kumar and Sidhu (2005) made an effort to pinpoint the push and pull factors that affect the employees' interstate migration.

The research concluded that the most significant pull factors that induce labor to migrate are industrial development, attractive employment prospects, and Punjab's comparably higher salaries. The study also noted that in the practice of migration, economic considerations are more important than non-economic ones. The study suggests that labor migration should be controlled in light of the urban industrial sector's poor rate of absorption. To lessen the disparities between the economic prospects in the urban and rural sectors, proper planning and successful execution are required. The effectiveness of various brick-making technologies used by both hand-made and machine-made brick units has been closely examined by UNIDO, which has also conducted a cost comparison analysis of the production, drying, and burning processes. It is expected that hand-made bricks cost 29% less than machine-made bricks. Also, it was also discovered that in developing nations, the marketing of handmade bricks in is entirely carried out by middlemen, who are responsible for the noticeable discrepancy in price between the "kilns price" and the "delivered price" of handmade bricks.

Inbaraja et al. (2013)in their research find out that the musculoskeletal diseases (MSD) that brick kiln employees experience at work are closely linked to their uncomfortable postures, which also have an impact on their activities of daily living (ADL). The frequency of MSD is also significantly impacted by extended service years and overwork. To address morbidity associated with MSDs, this study suggests doing thorough research, educating employees about their health, and enforcing and monitoring legislation in the unorganized sectors.

In their study Bhat et al. (2014) reveals that the main factors contributing to the environment's decline in terms of air pollution, health issues for people, and decreased crop productivity are emissions from brick kilns, urbanization, and transportation. Global warming will also result from this. Thus, it can be said that ambient air pollution caused by brick kilns in rural regions poses a serious threat to both plant and human health.

According to GKSPL (2013-18), many brick and tile industries in Punjab are on the verge of closing down because of a severe scarcity of high-quality clay. The problem can

be solved by increasing technology while using less clay as a building material. For the brick and tile business, solid waste like as red mid, fly ash, iron ore rejects, tannery sludge, and mineral tailings are excellent substitutes for natural clay.

In their study article, Uma et al. (2014) assess the air pollution emissions from various commonly used brick-making technologies in India and compare the emission levels from VSBK operations in Vietnam and India. As per study vertical shaft bull trench kiln suggested alternative of old types of kilns. Study reveals that VSBK are more efficient than traditional kilns like Clamp or Pazwaha kilns.

2.2. Critical analysis

Numerous aspects of the brick kiln sector or industry have been studied, including the effects on the environment, working conditions, new technical advancements, and regulatory consequences. Significant environmental damage linked to brick kilns has been shown by past studies. This damage includes soil degradation, sulphur dioxide, nitrogen oxide, and particulate matter emissions that pollute the air (Bhat et al., 2014; GKSPL, 2013–18). Studies have shown that the mining of clay and the burning of wood fuel in brick kilns contribute to deforestation and soil deterioration. The carbon footprint of brick kilns has been measured, and sustainable solutions including alternative fuels and cleaner manufacturing methods have been investigated. However, earlier research has also looked at the working conditions of those employed in brick kilns, drawing attention to problems like low pay, long hours, a lack of workplace safety precautions, and the exploitation of children and migrant workers (Aggarwal, 1959; Patil, 1975; Rao, 1981; Puri, 1983; Singh, 2003; Inbaraja et al., 2014). Research has looked at the socioeconomic effects of brick kilns on nearby communities, such as poverty, social marginalisation, and displacement.

Previous research has concentrated on technical advancements meant to enhance brick kiln efficiency and environmental performance. Research has examined the implementation of greener manufacturing technologies, such tunnel kilns and vertical shaft brick kilns (VSBK), as a means of lowering energy and emission levels(Uma et al.,

2014; Hiralal and Manjumar, 1979). Studies have also looked into the viability and expandability of using different building materials and construction methods in place of conventional clay bricks.Studies have evaluated the efficacy of legislative initiatives and regulatory structures designed to lessen the negative effects brick kilns have on the environment and society. Research has looked at how international cooperation, market incentives, and government regulations might support sustainable practices in the brick kiln industry (Yagnik, 1983; Gupta, 2003). A lot of work has gone into identifying policy gaps and suggesting ways to improve enforcement mechanisms, encourage technology transfer, and aid in stakeholders' capacity building.

In a nutshell, though the previous studies on the brick kiln industry have advanced our knowledge of its social and environmental complexity and offered suggestions for future directions in policy change and sustainable development, there are still a lot of obstacles to overcome, and more studies ate required to address new problems and expand effective therapies.

2.3 Technology and Innovation

According to Kelly et al. (2012), technology presents a "potential resource of options and possibilities" that may contribute to cost and time savings for organizations. The nature of its technology and the knowledge associated with it are closely related to the knowledge that, when put into use, can give businesses an economic benefit. Innovation, as per Stal (2007), is the formation of any new technique, instrument or apparatus that has the potential to alter how products are marketed. Zawislak (1994) tackles technology through knowledge, i.e., "new appliances, new methods, new ideas, new techniques, and new technologies." that have an impact and spur growth. Knowledge has a connection to technology's nature, can be respected by Taken and Epistem, and is recognized as technical, i.e., a direct knowledge for the practice of something and universal, analytical, mental knowledge founded on theory. Therefore, it targets the logical study of the phenomenon and has technology as a technique attached to the logo. He claimed that technology can spur development, so businesses implement new ones to enhance internal

operations and, as a result, provide better services and goods to stay competitive. According to Arthur (2011), technological innovation serves as the primary catalyst for economic development. It serves as a foundation for organizations to adapt to the market demands imposed by globalization (Mussi and Canto, 2008).
Sustainable growth and minimizing the damaging effects of human activity on the ecosystem are two goals that are connected to green technology and manufacturing.

Green manufacturing refers to the process of designing, producing, and distributing products in an environmentally friendly and sustainable manner. Reducing waste, preserving energy and resources, and lowering the amount of pollutants released into the environment are all part of this. Reducing packaging, recycling materials, and using renewable energy sources are a few examples of green manufacturing techniques. Conversely, "green technology" describes the development and application of new technologies that mitigate the deleterious effects of human activities on the environment. This includes innovations that support trash minimization, energy economy, renewable energy, and water saving. Wind turbines, solar panels, electric vehicles, and energy-efficient products are a few examples of ecological innovations. Both green manufacturing and green technology are important for achieving a more sustainable future. The adverse effects of human activities on the environment can be mitigated by waste reduction, resource conservation, and the development of innovative technology.

The Oslo Manual is a widely recognized international reference guide for measuring innovation. Innovation is explained as the introduction of a novel item or procedure, a fresh approach to advertising, or a novel style of company administration, management, or public relations. Innovation is obviously portion of a business plan on the basis of changes in the importance of ideas," Oslo Manual (OECD, 2010). In general, "good services or processes, product" and can be constructed as process, product, advertising and organizational novelty. According to Tiger (2006), in the context of business, innovation can be described as the creation and application of new processes, ideas, services or products that result in significant improvements in business operations,

market competitiveness and customer experience. In context to the nature of alteration, Quinn and Weick (1999) differ in this: incessant alteration (accumulated, busy, continuous, and emerging flows, which occur day by day viaadvancements of social practices and manufacturingprocedures) or episodic changes.

As per Roger (1995) an innovation is a concept, behavior, or product that regards an individual as novel.It takes a while for it to be accepted and incorporated into society, despite the fact that it can have many advantages. To pinpoint the facetsthat influence the adoption and acceptance of innovation, several ideas have surfaced.For example, the TAM(hereafter Technology Acceptance Model) by Davis (1989), IDT (Innovation Diffusion Theory) by Rogers (1995) and the UTAUT model by Venkatesh et al. (2003).

2.4 TAM

Integrating human actions from the fields of sociology, psychology and information management science has slowly become a part of technology acceptance systems. The study of technologicalapproaches adoption increased the bar for creating those same models. These models then make predictions by taking into account a wide range of technology acceptance parameters.

2.4.1 Theory of Reasoned Action (TRA)

Fishbein(1975) introduced the TRA, which maintained that a person's behavioural purpose dictated their behaviour. Ajzen and Fishbein (1975) subsequently enhanced and broadened their idea that pinpoints a person's intent before they do action.A social psychology model known as TRA (Theory of Reasoned Action), explains how people develop attitudes and make choices based on their attitudes, beliefs, and intentions. The theory was primarilypresentedin 1975 by Ajzen and Fishbein, as an enhanced version of their earlier work on the Theory of Attitude and Behavior. In accordance with the TRA, behavior of an individual is resolute by two factors: their attitude towards their subjective norm and the behavior. Attitude corresponds to an individual's negative or

positiveassessment of the behavior, while subjective standarddenotes to the social burden that an individual observes to execute or not to execute the behavior.

According to the TRA, a person's desire to carry out a certain activity is the best indication of their true conduct. The person's mindset towards the behaviour and their subjective standard determines the person's purpose. Positivity in one's attitude regarding the behavior results in stronger subjective norm to perform the behavior, and also in increased probability of one's wish to execute that behavior. The TRA also emphasizes the importance of beliefs in shaping attitudes and subjective norms. Beliefs are observations of an individual about the consequences of performing the behavior, and they influence subjective norms and attitudes. According to the TRA, people are more likely to think behaviour will result in good results if they have a positive attitude towards it and feel it is socially burdensome to engage in it. Peterson and Bredow (2009) assert that the TRA is not completely accurate at forecasting behavior. According to Ajzen (1991), there are other elements that have an impact on how people behave in addition to attitudes, perceived behavioral control, and subjective standards. Only 40% of the variation in behavior is allegedly explained by TRA, according to studies that used empirical validation (Ajzen, 1991; Bredow and Peterson, 2009). Additionally, researchers discovered that the TRA disregarded social variables that might influence a person's behavior (Mykytyn and Grandon, 2004).

2.4.2 Diffusion of Innovation Theory (DOI)

The DOI model integrates three key elements namely the invention decision process, the features of the invention, and adopter characteristics. The invention decision process generally undergoes five stages namely confirmations, knowledge, implementations, decisions, and persuasion. These encompass a sequence of communication channels among the associates of a comparable communal scheme for a short period. Comparative advantage, intricacy, compatibility, permeability, and testability form a part of innovation characteristics and are effective in innovation acceptance. Initial users, Initial Majority, Late Majority, Innovators, and Stragglers are the user's characteristics (Sila et al., 2015).

On the whole, the DOI focuses more on organizational attributes, environmental aspects, and system characteristics and less on the predictability of outcomes.

2.4.3 Social Cognitive Theory (SCT)

In order to predict both individual and group behavior, SCT was derived from social psychology with the objective of identifying methods that can modify behavior (Rana and Dwivedi, 2015). The SCT was based on an inseparable triadic structure consisting of three bi-directionally interactive factors namely environment, personal, and behavior. The behavior factor focuses on adoption, usage, and performance issues, the personal factor on demographic and personality aspects, and the environmental factor on external aspects.

2.4.4 Theory of Planned Behavior (TPB)

The TRA was unable to enlighten behavior that relied on how well-controlled it was, leading to the development of TPB. As a result, TPB was suggested by Ajzen and Fishbein (1970) as an addition to the TRA system. The Theory of Planned Behavior's fundamental idea aims to foresee conduct in which people lack ample self-discipline. This extension, Perceived Behavioral Control, is made to understand the external influences that might have an impact on a person's purpose or behavior. TRA examines a person's attitudes towards a specific action including the personal standards of persons who can affect those attitudes. The assessments of behavioral purpose and measured behavior have a notable gap, according to Peterson and Bredow (2009). The results of this research imply that a person's attitude may alter suddenly. Additionally, it was implied that TPB is a predictive model that makes predictions about an individual's behavior based on a set of criteria, but that the person is not always consistent with the behavior anticipated by those standards.

To explain human behaviour and decision-making, social psychologists have developed a theory known as the Theory of Planned Behaviour, or TPB. According to the idea, people's actions are determined by their objectives, which are influenced by three factors:

their perceptions of their own behavioural control, subjective norms, and attitudes towards the activity. Subjective norms describe the perceived social pressure to participate in an activity or abstain from it, whereas attitudes provide one's positive or negative assessment of a person's behaviour. Perceived behavioural control is the idea that an individual can do an action while accounting for any outside supports or constraints.

The notion states that a person's desire to participate in an activity rises in direct proportion to their positive feelings towards it. A person's desire to carry out the behaviour is also likely to be greater if they believe that it is socially acceptable or that important people support them. Ultimately, a person's intention to carry out the behaviour is probably greater if they believe they have control over it. The TPB has been used to evaluate a wide range of behaviors, including those that are connected to health, like nutrition, exercise, and smoking, as well as those that are related to the environment, such recycling and energy saving. The theory has been applied to develop programmes intended to change conduct by concentrating on attitudes, arbitrary standards, and perceived behavioural control. It has been proven to be a useful tool for understanding and anticipating behaviour.

2.4.5 The Model of PC Utilization (MPCU)

To predict individual's utilization of PC use, this model can be used. Behavioral intention is excluded from this model as it assesses the actual behavior itself. The model precisely assesses the direct impact of facilitating conditions, continuous usage, peer influence, job fit, and complexity on behavior. Results show that complexity, continuous usage, job fit, and social factors have strong influences on PC usage. Despite habits being a robust forecaster of behavior, it has not been included in the PC utilization model (Oye et al., 2014).

2.4.6 Motivational Model (MM)

The motivational model had task importance as a moderator. The model was based on intrinsic motivation (Perceived enjoyment) and extrinsic motivation (perceived usefulness). Intrinsic motivation helps students perform an activity without any apparent reinforcement, and extrinsic motivation makes students perform an activity to achieve valued outcomes (Davis and Bagozzi, 1989).

2.4.7 TAM

Fred Davis developed the TAM theoretical framework in 1989 to describe how consumers come to embrace and use new technology. As per the TAM, customer approval is influenced by two factors. One of the factors is perceived ease of usewhile the other one is perceived usefulness.

Perceived utility is the extent to which a user believes that a certain technique or piece of technology will enhance their capacity to carry out their tasks or provide better results. Perceived ease of use, on the other hand, relates to how much a person believes utilizing the technology would be simple. TAM has been applied to a wide range of technologies, including mobile applications, internet, and business software, and has been widely employed in the field of information systems research. Information systems and user interface design and assessment also commonly employ TAM. Over time, TAM has been expanded upon and improved; as a result, other iterations of the model, such as the TAM2 and the UTAUT have been developed.

2.4.8 The evolution of Unified Theory

By combining the available models based on accuracy, robustness, and relevance, numerous studies have tried to develop a unified theory of technology adoption (Aggarwal and Karahanna, 2000; Koufaris, 2002; Chau and Hu, 2002; Zhuang, Maupin, Lederer, and Sena, 2000; Moon and Kim, 2001). The ability of the successful models to be interpreted will be improved, according to Jen et al., (2009), by including novel

variables and constructs. In order to examine the appropriate user behaviors towards technology, these sets of models were chosen based on research in psychology, computer usage, sociology, and innovation theory. When developing novel models or theories, Venkatesh and Davis (2000) suggested that researchers take parsimony of existing models into account. Parsimonious here refers to reducing the model or theory to factors with the strongest explanatory power and the fewest assumptions.

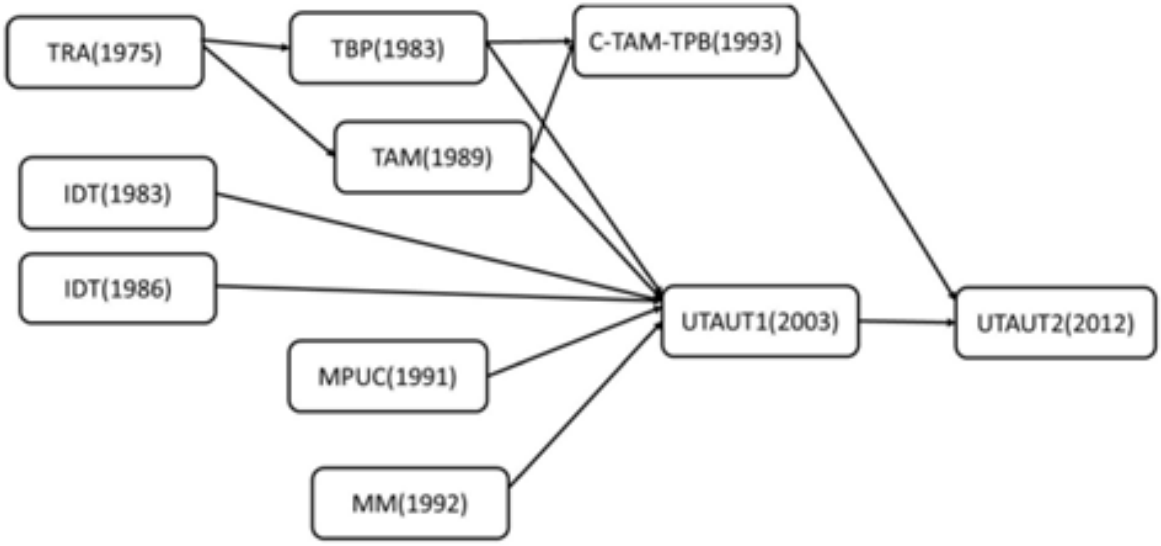

Figure 2.1: Evolution of Utaut Model

The TAM, one of these models and theories, was widely used to gauge technology acceptance prior to the development of the UTAUT model. The TAM hypothesis states that a user's internal beliefs, intensions, and attitudes can be used to explain technology acceptance and its use. However, TAM's drawback is that it can predict actual smart phone usage rather than just the social reasons people use technology (Turner et al., 2010).According to Jen et al., (2009), earlier studies using the TAM theory did not consistently produce conclusions about how to establish causal relationships with variables. It is envisaged that knowledge of causal links will help evaluate the reliability of correlations between factors like desire to use, actual usage, and one's perspective about usage. According to Jen et al., (2009), the UTAUT provides a more thorough investigation with its key predictor variables, which include performance expectancy

(perceived), behavioral intention (attitude towards use), social influence (subjective norm) and effort expectancy (perceived ease of use).

2.4.9 UTAUT1: After reviewing earlier studies that provided a hypothetical foundation for UTAUT1, Venkatesh et al., (2003) suggested the theory. This model is comprised of eight main Information Systems (IS) constructs, along with their advantages and disadvantages. TAM and TAM2, Motivational Model (MM), Theory of Reasoned Action (TRA), Model of PC Utilization (MPCU),Theory of Planned Behavior (TPB),Social Cognitive Theory (SCT) and Innovation Diffusion Theory (IDT), are among the categories and mediators of UTAUT1 (Raman and Don, 2013; Wang et al., 2009; Slade et al., 2013). The goal was to create a single, comprehensive theory called the UTAUT; Venkatesh et al., (2003) did research using data from 4 organizations. According to this model, the dependent factors Behavior Intention and User Behavior are directly influenced by four different variables: Performance Expectancy, Social Influence, Effort Expectancy, and Facilitating Circumstances. Moderators which are concerned to individual differences were added to the UTAUT1 model. The moderators were gender, voluntariness of use, experience, and age (Figure 2.2).

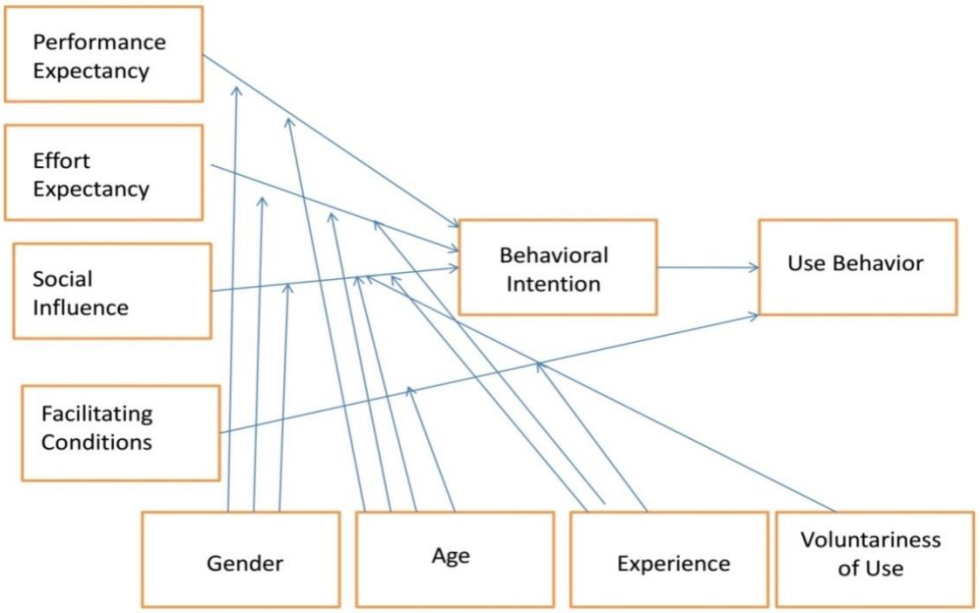

Figure No.2.2 Basic UTAUT model

a. **Performance expectancy:** In UTAUT), "Performance Expectancy" pertains to how confident a person is that the implementation of a given piece of technology will improve their efficiency and productivity.

   To put it another way, it's the degree to which a person thinks they'll be better off carrying out a task or dealing with an event after implementing a technological solution. The perceived utility of the technology, the individual's familiarity with similar systems, and the difficulty of the assignment at hand are all important contributors to this concept. The UTAUT model suggests that the higher the individual's perceived performance expectancy, the more likely they are to adopt and use the technology. So, it is important for technology developers and designers to understand the factors that influence performance expectancy and to design technology that enhances user performance and makes tasks easier to accomplish.

b. **Effort expectancy:** One of the most important parts of the UTAUT is the Effort Expectancy construct. The term "user experience" is used to describe how simple or complicated it is for someone to operate a piece of technology. It's the amount of trouble people think they'll have to go to in order to use a piece of technology. Intent to use a technology system, in turn influenced by Effort Expectancy, affects actual usage behavior, as proposed by the UTAUT. A person's likelihood of intending to use and actually using a technological system increases if they believe that doing so will entail less work on their part.

   In sum, the Effort Expectancy concept is a critical component that can affect people's propensity to learn and use new forms of technology. Designers and developers of technological systems can improve the likelihood of their products being used by the general public by better catering to consumers' Effort Expectancy.

   c. Social Influence: An explanation for how and why people start using new technologies is provided by the UTAUT. Social influence is a crucial concept in this model, and it pertains to how much someone thinks their significant others

think they should adopt a certain technique. Social influence can be further broken down into two types: normative and informational influence. Normative influence is the way in which a person believes that others consider them to be obligated to make use of a given technological tool. Conversely, the extent to which one is influenced by the informational beliefs of others depends on the extent to which they themselves are knowledgeable and experienced with the technology in question. Normative influence is important because it can create social pressure for individuals to adopt and use technology. If an individual perceives that their peers or colleagues expect them to use a particular technology, they may be more likely to do so. Informational influence is important because it can provide individuals with valuable information about the technology, which can increase their confidence and competence in using it. Overall, social influence is a critical factor in determining whether or not individuals will adopt and use technology. By understanding the different types of social influence and how they operate, technology developers and implementers can design interventions that effectively promote technology adoption and use.

d. Facilitating conditions: When we talk about "facilitating conditions," we're talking about how confident someone is that they'll have access to the tools and information they need to successfully implement a technological solution. Some examples of facilitating conditions include technical support, training, and access to necessary equipment and infrastructure.

In UTAUT, facilitating conditions are seen as an important factor that can either hider or support the adoption and use of technology. Users have a greater opportunity to hold a favorable opinion regarding technology and increase their frequency of usage if they feel they have the facilities and assistance they need to make the most of it. On the other hand, if users perceive that there are barriers or obstacles to using technology, such as a lack of technical support or inadequate training, they may be less likely to use it or may use it less effectively.

e.Use Behavior: UTAUT included eight theories, state that the purpose is to utilize the real usage of technology directly and positively (Venkatesh *et al.*, 2003). UTAUT is a theoretical framework utilized to describe and forecast individuals' adoption and practice of technology. UTAUT identifies 4importantconcepts influencing technology adoption besides usage: performance expectation, effort expectation, societal impact, and enabling circumstances. Behavior, or the real usage of technology, is a critical outcome variable in UTAUT. The theory suggests that the four constructs mentioned above affect individuals' behavioral purposes to utilize technology, which sequentially impact their real practice. In other words, an individual's perception of a technology's ease of use, usefulness, social pressures to use it, and the availability of necessary resources all influence their decision to use the technology, which ultimately leads to their actual use of it.

2.5 Research Gap

After reviewing the available literature, it is apparent that different researchers have focused on different issues relating to the brick kiln industry. They studied the problems and prospects of the brick industry, Production and marketing, living and working condition of laborers especially female laborers, and immigrant laborers, employment generation, environmental issues, and clustering of brick units in certain regions and reported in the literature. Still, there is scope for further study in the brick industry. In India, the brick industry occupies a significant position, since it is a labor-intensive industry and also a major construction material in the country. At the same time, the industry is facing many problems like shortage of raw materials, technology stagnation, labor problems, environmental issues, and many more.

1. The World Health Organization (WHO) reports that annually air pollution is responsible for around 7 million untimely fatalities. Recently, the Global Air Quality Report-2019 was published, and it revealed that

fourteen of the twenty most polluted places on earth are located in India, with Ghaziabad ranking top. Industrial, agricultural burning and vehicles are the main contributors to air pollution in Punjab. Over half of all PM10 emissions (47%) come from industry, while the next two biggest sources are brick kilns and open fires (CPCB, 2010; Envis Punjab, 2015). These figures shows acceptance of green technology is how much important**.** In the past studies on brick kiln industry, this concept is totally ignored.

2. The goal of this research is to use the UTAUT model in brick kiln sector. The scholar looked through numerous databases like Science Direct, Pro-quest, and EBESCO but was unable to locate any articles that used the UTAUT model to analyze brick kiln businesses. This research study will explore factors like performance expectancy, effort expectancy, social influence and facilitating conditions, which are impacting behavior intention of users for acceptance of green technology.

3. Present study will explore potential impact of different moderators' education and firm size as taken in previous study by Uddin et al., (2019). In their study they concluded that firm size and education level greatly impact acceptance of technology.

4. Although work has been carried out on the aspects like influence of brick industry on environment (Khan et al., 2019) and well-being of labor working in brick kilns etc. (Pelleng et al., 2021),but one of the important aspects of adoption of green technology is generally ignored and only a few researches have been found in literature on this aspect. The present study is intended to research upon the adoption of green technology in brick kiln industry of Punjab with application of UTAUT model.

CHAPTER-3

RESEARCH METHODOLOGY

The term "research methodology" refers to the systematic and logical approach utilized by researchers in designing, conducting, and analyzing research studies. It involves adhering to a predetermined set of guidelines and protocols throughout the entirety of the research process, from the formulation of hypotheses or research questions to the collection of data and its interpretation.

There are numerous research approaches, each of which is accompanied by its own set of techniques, including the following:

1. **Quantitative research methodology:** This approach involves collecting and analyzing numerical data through statistical methods. It focuses on testing hypotheses and making predictions about phenomena.
2. **Qualitative research methodology:** This approach involves collecting and analyzing non-numerical data through methods such as observation, interviews, and focus groups. It focuses on understanding the meaning and interpretation of phenomena.
3. **Mixed-methods research methodology:** This approach involves combining both qualitative and quantitative methods to address research questions or hypothesis and provide a more comprehensive understanding of phenomena.

The research methodology includes following steps

- Formulating testable hypothesis or research questions
- Conducting review of literature
- Developing a robust research design
- Data collection
- Data Analysis
- Interpretation of results

- Communicating findings and conclusions.

Primarily, the problem identification, need, significance; objectives and scope have been discussed in this chapter to compose a framework of his particular study. The conceptual framework of adoption of green technology has been proposed and measures of its proposed antecedents have been summarized. Furthermore, data collection and sampling methodology have been discussed. Finally, SEM models based on respondent‘s responses have been described.

3.1 Need and Significance of the Study

India comes on second place in bricks production worldwide; having almost 200,000 brick kilns and an annual output of approximately 250 billion bricks (Reuters, 2019). The ever-increasing population necessitates the construction of millions of new buildings and homes each year due to rapid industrialization and urbanization. It has made manufacturing one of the most prosperous industries in India. Due to these factors, the building materials industry is one of India's industries with the highest growth rate. Significant amounts of natural resources, energy, labor, and capital are consumed by these industries. According to Eco-business reports (2016), the industrial sector in India is responsible for about 15% of all black carbon emissions, with brick kilns accounting for about two-thirds of those emissions, or 9%. The sector annually consumes between 35 and 40 million tons of coal. In India and other developing countries, brick is one of the most essential construction materials. Brick production is prevalent in India, with the majority of producers located in rural and semi-urban areas.

In Punjab there are about 2800 kilns as per the Punjab State Council for Science and Technology. To control air pollution Punjab government promoting different green technologies, like Zig-zig technology, biogas kiln etc. In Punjab most of brick kilns are converted into Zig-zag technology. Subsequently, previous studies have only examined the relationship between a small numbers of variables, and there is no research on the adoption of green technology within the context of the UTAUT Model.

3.2 Objectives of the study.

1. To investigate whether Performance Expectancy (PE), Effort Expectancy (EE) and Social Influence (SI) affects decision maker's behavioural intention for green technology in brick kiln firms.

2. To examine the moderating role of demographic variables (experience and education) in the defined relationships among constructs taken.

3. To examine the moderating role of voluntariness to use and firm size in the defined relationships among constructs taken.

4. To investigate the influence of facilitating conditions (FC) on actual usage of the green technology.

3.3 Scope of the study

The increased interest in usage of Green Technology basically refers to adoption of environment friendly technologies and practices. These technologies will facilitate in reducing the adverse effects of human activities on the natural environment. The UTAUT explain the factors that influence individuals' adoption and usage of green technologies (Wommer et al., 2022; Al-Emran et al., 2021).Drawing upon the UTAUT framework k, this study concerning green technologies will examine the factors, which influence the acceptance and utilization of green technologies by the individuals. The UTAUT model identifies four key determinants of technology acceptance and use:

Effort expectancy, facilitating conditions, social influence, and performance expectancy

Effort expectancy entails degree to which people believe using the technology will be simple or convenient. In the case of green technology, this could involve analyzing

factors such as the technology's ease of use, the availability of the required infrastructure, and the level of investment required to adopt the technology.

Social influence means that the individuals perceive what other (e.g., society members, peers, colleagues, or family members) approve or disapprove of using the technology. In the case of green technology, social influence may play an important role in influencing individuals' perceptions of the value and importance of environmentally friendly practices.

Facilitating conditions pertains to the way in which people have access to the resources required to effectively use technology (e.g., technology infrastructure, training, or support). In the case of green technology, facilitating conditions could include investigating the availability of funding or incentives to encourage the adoption of environmentally friendly practices.

Performance expectancy is the extent to belief of individuals about the technology that it may lead to enhancement of their performance or productivity. In the case of green technology, individuals may perceive that using these technologies will help them reduce their environmental impact, save energy or resources, and contribute to a healthier environment.

Overall, the scope of study in the use of green technology in the context of UTAUT would involve examining the factors influencing individuals' acceptance and usage of environmentally friendly technologies and practices, as well as the potential barriers to adoption and use. These insights can help researchers, policymakers, and businesses develop strategies to promote the adoption of green technology and create a more sustainable future.

3.4 Conceptual framework

On the basis of above-mentioned research gap identified, certain constructs are taken into consideration and a research model is proposed to know the relationship between various constructs.

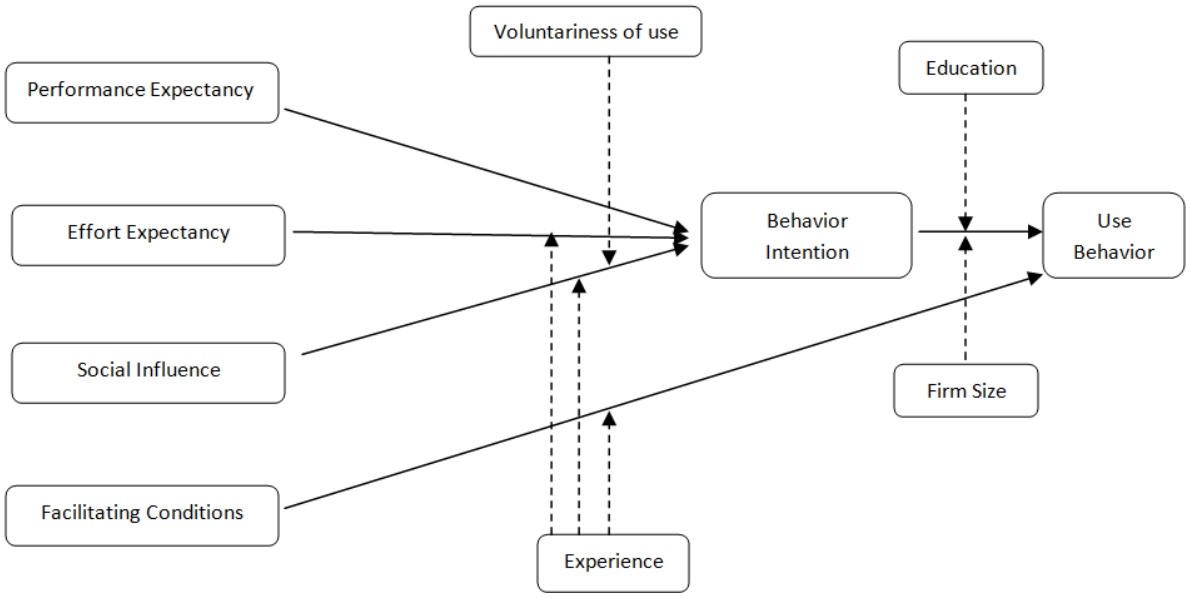

Figure 3.1: Conceptual model.

3.5 Hypothesis formulation

An unproven proposition to a decision problem is referred to as a hypothesis, which can be empirically evaluated on the basis of data collected during the research process. A hypothesis is also created in order to provide explanation for a phenomenon or a relationship between two or more variables. Malhotra and Dash, 2011 stated that the formulation of null hypothesis (H0) is based on the statement of no difference or no effects. In adoption of technology context there are 8 models and theories like, UTAUT, Innovation Diffusion Theory, Model of PC Use, Motivational Model, Hybrid TAM-TPB Model,Social Cognitive Theory, TRA theory, and TPB, on which the UTAUT formulation is based. On the base of thorough investigation of these eight theories and

models, users' intentions to adopt technology were significantly influenced by Social Influence (SI), Performance Expectancy (PE), Facilitating Conditions (FC) and Effort Expectancy (EE)(Ghani and Rahi, 2018b; Venkatesh et al., 2003b). In order to draw conclusions about the target population, the following hypotheses are developed for the research based on prior studies:

- **Performance Expectancy (PE):** Performance expectancy means that a person believes that technological advancements will help improve job performance. According to numerous studies, PE significantly effects users' behavioral intentions for acquiring new technologies (Oliveira, 2016; Martins, 2014; Foon and Fah, 2011; Khalil et al., 2010; Abu Shanab et al., 2010). Based on available evidence, the proposed rationale for PE is as follows:

***H*$_1$: Performance expectancy significantly impacts behavior intention.**

- **Effort Expectancy (EE):** The perceived ease of using new techniques or technologies is known as the effort expectancy. This concept resembles three variables from the eight principles: "ease of use of TAM," "complexity of MPCU," as **well** as "ease of use" of IDT. Just like performance expectancy, usage intention is greatly impacted by effort expectancy. The technique is used either voluntary or imperatively (Venkatesh et al., 2003). As a result, the study put forwards following hypothesis:

***H*$_2$: Effort expectancy significantly impacts behavior intention.**

- **Social Influence (SI):** It is the level at which a person weighs whether or not powerful individuals back the use of a technology. The link between SI (Social Influence)and BI (Behavioral Intention) is widely discussed. SI refers to the pressure, which society puts on a person to adopt new technologies (Bisht and Kesharwani, 2012; Martins et al., 2014; Chaouali et al., 2016). In their study, Martins et al. (2014) claim that SI favorably impacts the users' intentions to use or

adopt new technology. On the basis of given arguments SI is hypothesized as follows:

***H_3*: Social influence significantly impacts behavior intention.**

- **Facilitating Conditions (FC):** The concept of facilitation evolved from the notion of perceived **behavioral** control, and it implies that system users in the workplace require accessibility of system. It is asserted that a lack of infrastructure may make individuals less apt to use technology. According to Hong et al., (2008), "Users would be less likely to use information technology if they lacked the fundamental operating skills." (IT). Researchers assumed that the enabling situation has a substantial effect on consumers' behavioural purpose to adopt and use new technology in line with previous study (Oliveira et al., 2016: Martins et al., 2014). On given arguments FC is hypothesized as follows:

***H_4*: Facilitating conditions significantly impact use behaviour**

- **Behavior Intention and** actual **use:** Behavior intention being an antecedent of usage behavior indicates the user's readiness to perform a specific action. Moreover, actual behavior is "the manifest, observable response in a given situation with respect to a given target" (Ajzen 1991).Resulting in following hypothesis:

***H_5*: Behaviour intention significantly impact use behaviour.**

- **Experience:** It refers to the amount of time a user claims to have spent utilizing a specific **technology**. According to Coffman (2014), users frequently base their intentions on the knowledge they've gained from using comparable technologies in the past. Consequently, proposing following hypothesis:

H_6 **There is a significant impact of experience as moderator between social influence and behavior intention.**

H_7: **There is a significant impact of experience as moderator between Effort expectancy and behavior intention.**

H_8: **There is a significant impact of experience as moderator between facilitating conditions and behavior intention.**

- **Voluntariness of use:** It is the extent to which prospective adopters view the adoption decision as non-binding (Ramayah, 2010; Aggarwal and Prasad, 1997). Regarding voluntariness of usage, it is the extent to which usage of an **innovation** is viewed as voluntary or non-required (Ramayah, 2010; Moore and Benbasat, 1991). Consequently, this study aims to investigate the voluntariness of use through the following methods:

  H_9: **There is a significant impact of voluntariness of use as a moderator between social influence and behavior intention.**

- **Education:** Education is taken as moderator in UTAUT model. In previous study it is concluded that education of users affect the opportunities they get, choices they make, and preferences they have in the later part of their life. Though the association between usage of a technology and education might operate in any sort of settings–formal or informal (A. Shita et al., 2018). It is also found that technology adoption is relatively high in highly educated ones because the uncertainty and costs associated with technology adoption is minimized by apt education, training and information flow (Lleras-Muneyet al., 2002). Therefore, proposing following hypothesis.

  H_{10}: There is a significant impact of education as moderator between behavior intention and use behavior.

- **Firm size:** Early studies on the adoption of information technology revealed that size of organization is one of the most accurate predictors of this phenomenon. Astoundingly, only few studies examined the effect of organizational size on the

adoption and implementation of technology using UTAUT model. Likewise, large enterprises have a greater capacity for risk management, greater access to resources, and a more robust infrastructure for adopting technologies than small and medium-sized businesses (Jacobsen et al., 2018; Ishan 2018). Thus, proposing following hypothesis:

H_{11}: There is a significant impact of Firm Size as moderator between behavior intention and use behavior.

3.6 Research design

The overall plan or structure that guides a research study is referred to as its research design. It describes the procedures and methods that researchers will employ to collect and analyze data, as well as the strategies they will employ to ensure the validity and reliability of their findings. A profoundly designed study is critical to generate valid as well as reliable results that can advance knowledge and facilitate in better decision-making.

Research design comprises the following elements:

- **Research question:** A research question identifies the problem or issue that the study intends to address. It should be clear, specific, and focused.
- **Research method:** This refers to the approach that researchers will use to collect data. Common research methods include surveys, experiments, observational studies, and case studies.
- **Sampling:** The act of selecting study subjects or participants is known as sampling. To ensure statistical power, the sample ought to be sufficiently large and illustrative of the population being studied.
- **Data collection:** Data collection refers to the collection of information from participants or sources. Researchers can collect data through questionnaires, interviews, observation, and other means.

- **Data analysis:** It is the process of looking over and analyzing the information gathered during the research. Researchers may use statistical methods or other techniques to analyze the data.
- **Reliability and validity:** Validity pertains to what an experiment measures what it is intended to measure, whereas reliability refers to the consistency of results over time. Researchers need to ensure that their study is both valid and reliable, including employing appropriate measures and controlling for confounding variables.
- **Ethical considerations:** These are a set of guiding principles and standards that must be adhered to when conducting research on human subjects. The researchers are responsible for ensuring that their study respects the privacy and rights of the participants.

Overall, a well-designed research study requires careful planning and attention to detail at every stage of the process, from formulating the research question to analyzing the data and drawing conclusions. However, the research design is same as the broad plan which indicates that how the whole research project will be conducted. It must be simple, clearly defined as well as in written form. Fundamentally, research design is categorized into three types such as (1) Exploratory research design (2) Descriptive research design (3) Experimental (also called causal) research design. This study adopts descriptive research design. However, research design helps the researcher to clearly comprehend the concept of the technology adoption. The detailed review of literature has been done on adoption of green technology adoption. Basically, descriptive research design is related with specification of the problem and its solution in a more detailed and meaningful way. The well defined problem should be in the hand of the researcher. Assigning authorities of brick kilns have been taken as target population of the study.

Researcher has collected the information from the brick kiln sites of different districts of Punjab. Furthermore, Punjab comprises of three regions namely; Doaba, Majha and Malwa and sample for the present study has been collected from these three regions. In

Doaba region- Nawanshehar, Kapurthala, Jalandhar and Hoshiarpur have been taken; Tarntaran, Amritsar, Gurdaspur and Pathankot have taken under the Majha region and Moga, Ludhiana, Faridkot, Patiala, Firozpur, Sangrur, Barnala, Fazilka, Bathinda, Sri Mukatsar Sahib, Sri Fatehgarh Sahib and Mansa have been taken under the Malwa region. Except these 2 more districts of Punjab Mohali and Roopnagar has been taken for the data collection.

3.7 Sampling designing process

Instead of collecting data from an entire population, a statistical technique known as sampling is used to collect data from a particular subset of that population. This is in contrast to the prevalent practice of gathering data from the entire population. It is a method that bases findings about the entire population on a small sample size from a specified population (Zikmund, 2003 and Cavana et al., 2001). A sampling design is a process that a researcher would use to choose objects from the population for the study's sample. Particularly, this procedure is carried out prior to data collection (Malhotra, 2007).Five steps for sampling design process are as follows:

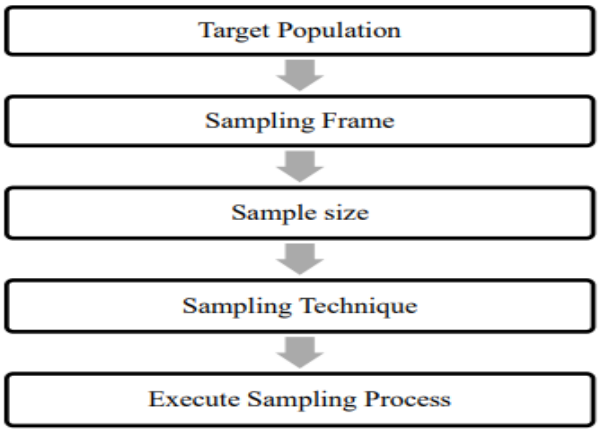

Figure 3.2: Sampling Design Process

3.7.1 Target population

The target population in sampling design pertains to the specific set of things or people that the researcher wants to investigate or draw conclusions about. This population is defined by the research question or goal. The present study's target population is the owners or assigning authorities of brick kilns in Punjab. The studies laid emphasis on only that firms which are using green technologies or having knowledge of Green Technologies. In Punjab brick kilns are in operation between the months of September to May.

3.7.2 Sampling frame

It is an exhaustive list of the items, people, and elements that comprise the entire population or universe. This population serves as the basis for drawing the required sample. There are three regions in Punjab namely; Doaba, Majha and Malwa and sample collected from these three regions of Punjab. Four districts namely-Nawanshehar, Kapurthala, Jalandhar and Hoshiarpur have been selected from Doaba region; four districts namely -Tarntaran, Amritsar, Gurdaspur and Pathankot have been included under the Majha region and ten districts namely-Moga, Ludhiana, Faridkot, Patiala, Firozpur, Sangrur, Barnala, Fazilka, Bathinda, Sri Mukatsar Sahib, Sri Fatehgarh Sahib, Mansa, SAS Nagar and SBS Nagar have been taken under the Malwa region.

3.7.3 Determination of sample size

Sample size is essential for setting up the representativeness of the population. Although, large sample size used for the research gives more reliable results but it is not compulsory to consider the entire target population to get best results. To ensure the proper coverage of required information, a sample of 340 respondents has been selected for the present study out of around 2800 brick kilns all over. A sample of around 340 respondents has been collected among the three regions of Punjab for the present study. The calculation of sample of 340 was carried out through Raosoft software (Rahi et al. 2019; www.Raosoft.com).

According to the sample size calculator (www.Surveysystem.com), 200 should be the minimal sample size but Raosoft software recommends a minimum sample size of 338. In management studies, 200–500 respondents are adequate to reflect the entire population, according to Hair et al. (2013). According to Pallant (2005), the sample size needs to be many (preferably five) times as many as the number of indicators that have been taken into account for the particular research. As a result, 44 indicators were collected for the current study (44 x 5= 220), indicating that 220 is the right number of samples to use.

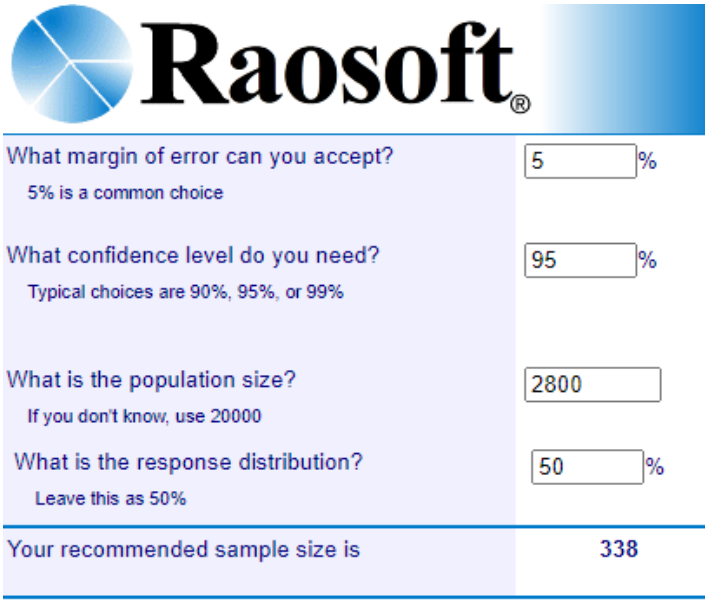

Figure 3.3: Calculation of sample size.

3.7.4 Sampling technique

Purposive sampling technique has been used for the collection of data (Varghese and Rajagopal, 2013, Isaac et al. 2022). The selection of the districts is based on the listing in Economic and Statistical Report in 2012.Purposive sampling (non-probabilistic sampling technique) is used in research. Only that brick kiln firms are selected which are using green technologies. This method is frequently used in qualitative research because it enables researchers to identify and choose participants that are most pertinent to the study's topic or objective. The researcher may use various criteria for selecting the sample, such as demographic characteristics, certain behaviors or attitudes, or specific experiences or perspective. Purposive sampling is considered useful when the research objective is well-defined and when the population being studied is small or unique. The main benefit of purposive sampling is that it enables researchers to collect more

comprehensive and intricate data that can better answer their research question. This method may also introduce bias into the research findings, as the sample might not be representative of everyone in the populace.

Researchers like Jusoh and Ling, (2012), Varghese et al., (2013), Allen and Brady, (1997) adopted the purposive sampling technique in their studies to collect the data from respondents. Respondents from each colony were selected on the purposive basis. The detail of the sample size of the respondents is displayed in the below table.

Table3.1: Detail of sample size

Sr. No.	Region	Districts	Number of Respondents
1	Majha	Amritsar, Gurdaspur, Tarntarn, Pathankot	67
2	Malwa	Ludhiana, Moga, Ferozepur, Barnala, Mansa, Patiala, Sri Fatehgarh Sahib, SBS Nagar, SAS Nagar, Sangrur, Bathinda, Faridkot, Fazilka, Sri Mukatsar Sahib	223
3	Doaba	Kapurthala, Jalandhar, Hoshiarpur, Nawanshar	50

3.7.5 Execution of sampling process

The processes involved in the sampling design process serve as the foundation for the sampling process' implementation. The sampling design process employed in this study is exhibited in Figure 3.4. The data is collected from December 2021 to February 2022 and September 2022 to December 2022 by using schedule.

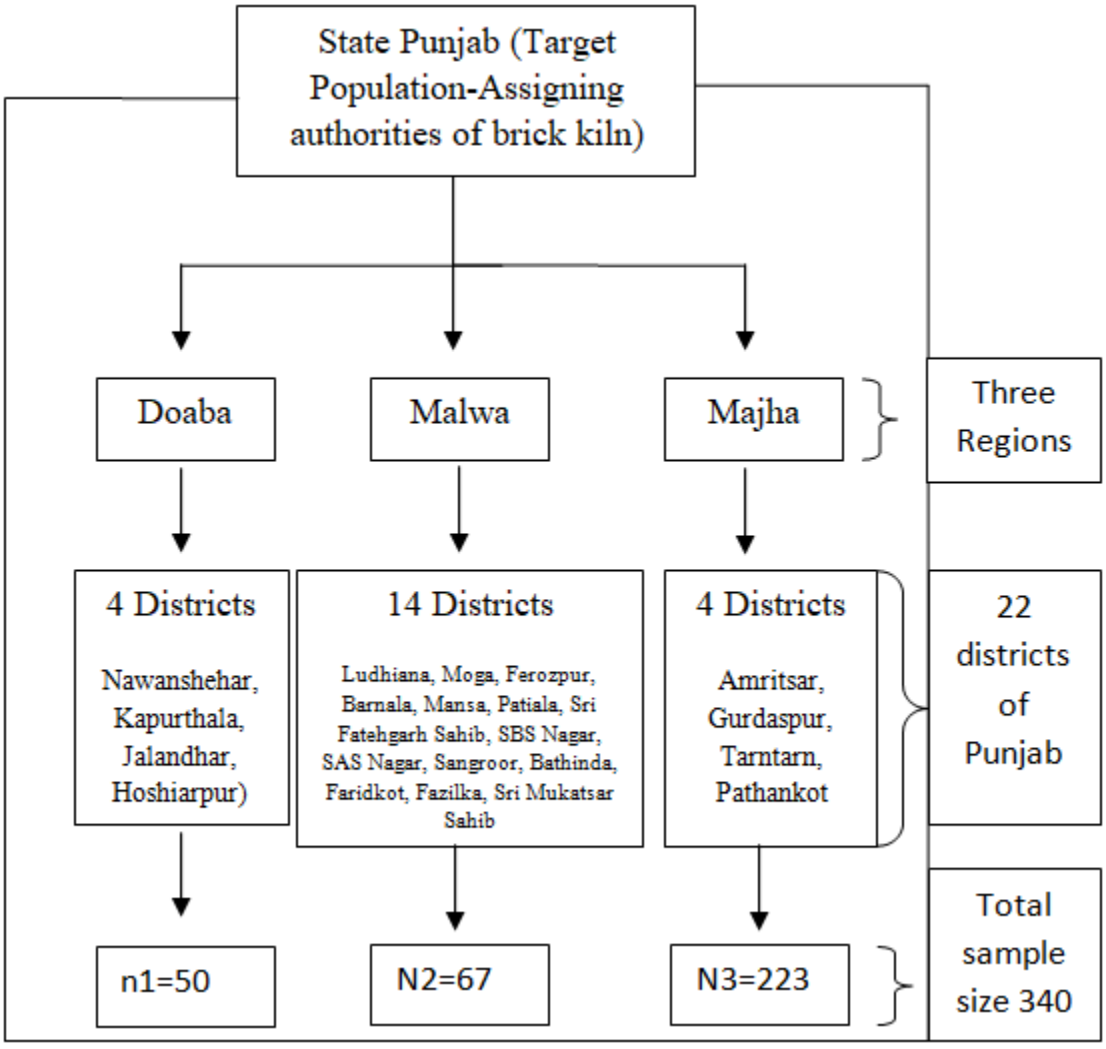

Figure 3.4: Sampling Design Process.

3.7.6 Measurement and instruments

To gather primary data, a properly designed and closed-ended Schedule is used. It consists of the following components: Behavior Intention, Use Behavior, Voluntariness of Use, Social Influence, Facilitating Conditions, Performance Expectancy, Effort Expectancy, and Voluntariness of Use. The respondents were asked to evaluate the

statements on a 5-point Likert scale (1-5), where 1 symbolizing "strongly disagree" and 5 symbolizing "strongly agree." This scale is a "frequently used rating scale that asks respondents to indicate the degree of agreement with each of the series of statements about the particular variable," according to Malhotra (2007).

The schedule is divided into two sections. Section-1consists of questions related to demographic profile of respondents, while section-2 consists of 44 multi-item scaled questions related to Social Influence, Performance Expectancy, Facilitating Conditions, Effort Expectancy, Behavior Intension, Use Behavior and Voluntariness of Use.

3.8 Harman's single factor test

Studies that gathered data from a single source may be vulnerable to variance bias, which is common in quantitative research (Rahi, 2017a, 2017b). Therefore, this research study incorporates Harman's single factor test for the common method variance (bias Podsakoff et al., 2003). The criterion for this test is total variance less than 50 percent. The results of Harman's single factor indicate the covariance of 32.863%, indicating this study to be free of such pertinent issues and suitable for inferential data analysis. Table 3.2 displays the results of Harman's one-factor test.

Table3.2: Result of Harman's single factor test.

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	14.460	32.863	32.863	14.460	32.863	32.863
2	2.677	6.084	38.948			
3	2.477	5.629	44.577			
4	1.861	4.230	48.807			
5	1.691	3.843	52.650			
6	1.611	3.661	56.311			
7	1.413	3.211	59.522			

8	1.308	2.973	62.496			
9	1.214	2.760	65.255			
10	1.041	2.367	67.622			
11	.952	2.165	69.787			
12	.897	2.038	71.825			
13	.870	1.977	73.802			
14	.786	1.786	75.588			
15	.771	1.753	77.341			
16	.717	1.631	78.971			
17	.669	1.520	80.491			
18	.645	1.467	81.958			
19	.625	1.421	83.379			
20	.585	1.330	84.709			
21	.550	1.249	85.957			
22	.496	1.128	87.085			
23	.478	1.086	88.171			
24	.444	1.008	89.179			
25	.422	.959	90.138			
26	.394	.895	91.033			
27	.384	.873	91.907			
28	.351	.797	92.704			
29	.329	.747	93.451			
30	.308	.701	94.152			
31	.291	.660	94.812			
32	.282	.641	95.454			
33	.253	.576	96.030			
34	.239	.543	96.573			
35	.230	.523	97.095			

36	.193	.439	97.534			
37	.178	.404	97.938			
38	.163	.370	98.308			
39	.152	.346	98.655			
40	.148	.335	98.990			
41	.141	.320	99.310			
42	.124	.282	99.592			
43	.092	.209	99.800			
44	.088	.200	100.000			

Extraction Method: Principal Component Analysis.

3.9 Pilot study

To assess the dependability of the specific instrument, a pilot study is part of the procedure for constructing the research tool. It was suggested to use the default sample of 30 participants during the early testing of the schedule (Perneger et al., 2015). Generally speaking, pilot testing should involve 30 individuals (Lancaster et al., 2004; Whitehead et al., 2016; Teare, et al.,(2014) stated that 30 is the ideal sample size for a pilot study. The researcher asked the respondents for their input on any kind of schedule adjustment that would be necessary. The following recommendations assisted the researcher to dispel various types of doubts:

1) Time taken for filling the complete schedule.

2) Identification of uncertain questions.

3) Identification of difficulty level of the schedule.

4) Identification of objection for any particular question.

5) Recognition to add something in the schedule.

3.10 Validity and reliability testing of the constructs

3.10.1 Validity

Validity refers to the capacity of a questionnaire or schedule to precisely measure what it is aimed at measuring. When assessing the validity of a questionnaire, researchers may take various types of validity into consideration. According to Malhotra and Dash (2011), validity is the quality of the questionnaire or schedule measuring what it is intended to assess. It can be assumed that research does not always take place in an ideal environment because measurement error is typically not zero. Accuracy and proper application are two requirements for evaluating multi-item scales in research in order to verify that there is no measurement error. Therefore, in order to guarantee the accuracy of the measurement instrument, it is essential that the validity and reliability of the constructs have been properly evaluated.

The content validity of the instrument has been validated by an expert in the applicable field to determine whether or not the items on the scale accurately cover the entire construct. To determine the degree to which an instrument produces consistent findings over the course of repeated measurements, the instrument's dependability has been investigated. When doing a research study, the results could seem to be reliable but may have some flaws. Consequently, it is crucial to keep in mind that precautions should be taken in order to lessen the likelihood that mistakes will be made when performing the research. Also, the data was coded using numbers to reduce errors while entering it into the computer. The simple and condensed timetable was designed to make it simple to understand the questions and to spot mistakes. The schedule was given to five experts in the relevant field to validate the content, and changes suggested by them were incorporated into the final draught of the schedule as well as given to 30 brick kiln signing authorities to ensure face validity.

3.10.2 Reliability

The reliability can be determined by calculating Cronbach's alpha based on the average of all conceivable split-half coefficients that emerge from different splitting of scale items using sophisticated software. Alpha counts greater than .70 (α>.70) is considered as acceptable fit for reliability of the construct (Mallery and George, 2011). More importantly, Cronbach's alpha (α) value as an indicator of internal consistency for various constructs of an instrument, calculated using statistical software SPSS 26.0. As alpha (α) values appears in ranging from .60 to .90 for all the constructs, the reliability of constructs used in the schedule has been tested and can be used for further analysis. In a nutshell, all kinds of validity and reliability have been duly compiled to make sure the correctness of measurement scales.

Table 3.3: Reliability Statistics

Based on sample size of 35	
Constructs	**Cronbach's Alpha**
PE	0.904*
EE	0.899*
SI	0.903*
FC	0.902*
BI	0.904*
UB	0.906*

*Acceptable range of Cronbach's alpha)

3.11 Summary of reliability and validity process

Keeping in view the above discussion, the content validity, face validity and reliability has been performed in an elaborated way. The result of reliability and validity indicated is satisfactory. To be precise, the result of these three processes has been concluded in one table. Table 3.5 showed the summary of reliability and validity process for the present study.

Table 3.4: Summary of Reliability and Validity Process.

Process	Details
(i) Content Validity Is the concept measured adequately with regard to the past research or the view point of concerned experts?	Expertise in the area of brick kiln industry.
(ii)Reliability How constantly a measuring instrument measures a concept?	Using internal consistency with Alpha> 0.70 (George and Mallery, 2011).

3.12 Source of data

The current research is descriptive in nature and schedule is used to collect data, which was then analyzed to determine whether the hypothesis was accepted or rejected. The primary and secondary data techniques were used to collect data through a formalized research process in order to solve the research problem. The primary data used in the research represents the first-hand facts and estimates that are originated by adopting sampling process from target population. The schedule was pre-tested before the final data collection method. Whereas secondary data has been collected from relevant articles, journals, books and web published materials.

3.13 Analysis technique

Data analysis is not just the last step in the research process; rather, it aims to produce the kind of data that will help the researcher solve the issue at hand. In order to meet the study's goals, the gathered data was analyzed. The data have been analyzed, and the findings have been interpreted, using the appropriate statistical tools. Using the SmartPLS-4.0 software, this study employs Structural Equation Model (SEM) (a multivariate data analysis technique) to attain the objectives of the study and to validate the hypotheses. Hypothesis testing has been conducted in order to find out whether the

hypotheses that have been made in accordance with review of existing literature were rejected or accepted. Data analysis was interpretive to obtain the relevant information regarding the factors affecting adoption of green technology in brick kiln firms. However, for the better understanding the characteristics of each variable, descriptive analysis was used to illustrate frequencies and demographics analysis of each variable.

CHAPTER-4

DATA ANALYSIS AND INTERPRETATION

This chapter discusses the data analysis as well as the clarification of the findings. The data is analyzed using statistical tools such as Smart PLS 4.0 and SPSS 21.0, as well as the required statistical techniques. Data analysis is performed to determine whether or not the study's objectives were met.Appropriate statistical approaches are employed to guarantee that all of the formulated hypotheses are well-supported and have a meaningful connection to one another variable. However, the main focus of this chapter is on validating the model with more sophisticated statistical methods and instruments.This chapter starts with the analysis of first part of schedule i.e., age, gender, education and experience of respondents followed by the demographic profile of signing authorities of brick kiln firms. Next, it elaborates the measurement model‘s validity such as Construct validation analysis (reliability and validity measures) and structural model analysis using the SmartPLS-4 software. Along with this, several summarized tables and figures have been included that describe and support the findings of the research. In the conclusion, the results of the proposed hypotheses testing are also presented.

4.1Demographic profile of respondents

This section begins with the respondent's name and then asked a series of additional questions to examine the demographic traits of the respondents.

- **Districts**

Table 4.1: Districts

	Sample size	**Percentage**
Amritsar	24	7.05
Barnala	07	2.05
Bathinda	25	7.35
Faridkot	08	2.35

Sri Fatehgarh Sahib	06	1.76
Fazilka	17	5
Ferozepur	12	3.5
Gurdaspur	17	5
Hoshiarpur	14	4.11
Jalandhar	21	6.17
Kapurthala	08	2.35
Ludhiana	36	10.5
Mansa	17	5
Moga	18	5.29
Sri Mukatsar Sahib	12	3.52
SBS	08	2.35
Pathankot	08	2.35
Patiala	18	5.29
Roopnagar	09	2.64
SAS Nagar	13	3.82
Sangrur	25	7.35
Tarn Taran	18	5.29
TOTAL	**384**	**100**

(Source: Author's calculations)

The above table describes the percentage of the cities from which the sample is collected. In brick kiln firms Ludhiana is on top with 281 kiln, so the largest sample is taken from Ludhiana i.e. 36 (10.5%) and it's followed by Bathinda i.e. 25 (7.35%) and Sangrur contributed sample of 25 (7.35%), Amritsar 24 (7.5%), Jalandhar 21 (6.17%) and from other districts sample size is below 20.

- **Gender**

Table 4.2: Gender

	Number	**Percentage**
Male	337	99.4
Female	3	.6
TOTAL	**340**	**100**

(Source: Author's calculations)

The table 4.2 below analyzes that most of the respondents are male n = 337, 99.4 percent, while only 3 (.6 percent) are females. In brick kilns firms mostly operations are handled by males. In brick kiln firms women also work but they comes in Pather (labor) category, but in data collection we have taken only assigning authorities of brick kiln firms.

- **Age**

Table 4.3: Age

Category	**Frequency**	**Percentage (%)**
18-30	17	5.1
31-40	141	41.5
41-50	122	36
51-60	45	13.4
61 &Above	15	4

(Source: Author's calculations)

The age of respondents is given in above table. It is found out that respondents lying in the age category of 31-40 years (141, 41.5%) are more engaged in this industry, reason behind that brick kiln owners give preference to young people. This category is followed by age category of 41-50 years, accounting for 36 percent of the respondents. In age category of 51-60 only 45 respondents comes in this, while in others categories 18-30 and above 61 age only 17 and 15 respondents comes in.

- **Position**

Table 4.4: Position

Category	Frequency	Percentage (%)
Owner	65	19.1
Supervisor	21	6.2
Thekedar	67	19.7
Munshi	120	35.3
Any other	67	19.7

(Source: Author's calculations)

The table 4.4 analyzes that most of the respondents are on Munshi position (120, 35%), followed by Thekedar (67, 19.7%) and owner category (65, 19.1%), while only 21 (6.2%) respondents were on supervisor position. Any other category of respondents comprises of people who are relatives and friends of brick kiln owners.

- **Experience**

Table 4.5: Experience

Category	Frequency	Percentage (%)
Less than 5 years	51	15.0
5-10	114	33.5
11-15	84	24.7
More than 15 years	91	26.8

(Source: Author's calculations)

The experience of respondents is given in above table. It is found out that most of respondents having 5-10 years' experience (114, 33.5%), followed by experience category of more than 15 years, accounting for 26.8 percent of the respondents.While 84

(24.7%) respondents from experience category of 11-15 years. Only 51 (15%) are those respondents who have less than 5 year experience, otherwise mostly respondents are more than 5 years' experience. Owners of brick kilns give preference to only experienced people of same industry.

- **Education**

Table 4.6: Education

Category	Frequency	Percentage (%)
High school	146	42.9
Graduation	157	46.2
Post graduation	17	5.0
Any other	20	5.9

(Source: Author's calculations)

The literacy rate of respondents is given in above table. 174(51.2%) respondents, who are engaged in brick kiln industry have possessed graduation and post-graduation level education, 20 (5.9%) have professional diploma and degrees, while 146 (42.9) respondentshave high school education.

- **Locality**

Table 4.7Locality

Category	Frequency	Percentage (%)
Rural	333	97.9
Urban	7	2.1
	340	100

(Source: Author's calculations)

Above table depicts locality of brick kiln firms. Most of brick kilns firms are situated in rural areas (333, 97.9%), while only 7 firms are situated in urban areas. Reason behind

that Punjab government had issued order on 2nd October 1998, in which it was mentioned that in urban area brick kiln should not be installed in radius of 1000 meters of residential areas, while in village or towns it should be not be in radius of 750 meters.

- **Age of firm**

Table 4.8: Age of firm

Category	Frequency	Percentage (%)
1-5 Years	7	2.1
5-10 Years	18	5.3
Above 10 Years	315	92.6

(Source: Author's calculations)

Given shows that 315 (92.6%) firms in operations from more than 10 years, while 18 (5.3%) firms in operation from 5-10 years. Only 7 (5.3) firms are in operations from 1-5 years.

4.2 Structural Equation Modeling- Partial Least Square (PLS)

Structural Equation Modeling (SEM) is a statistical technique used to test and validate a theoretical model that hypothesizes the relationship between different variables. Partial Least Squares (PLS) is a popular approach used in SEM to estimate and validate the relationship between latent constructs (unobserved variables) and observed variables.In PLS-SEM, the latent constructs are estimated using the observed variables, which are also known as indicators or manifest variables. The technique seeks to identify the linear relationship between the latent constructs and the observed variables by maximizing the explained variance in the observed variables.

A broad range of theories and research questions, including causal models, mediation models, and moderation models, can be tested using SEM. It is frequently used to evaluate large data sets in disciplines like psychology, sociology, and

economics(Christodoulides &Michaelidou, 2010,Chang et. al., 2009; Belli, 2017;Ghane, 2011; Flavian et. al., 2006;Christino et. al.,2019; Martins, 2017). The SmartPLS-4.0 program is used for SEM. It is possible to investigate the potential relationships between the structures using SEM. It accomplishes this by analyzing the causal relationships underlying the latent constructs (Hair et. al., 2011).

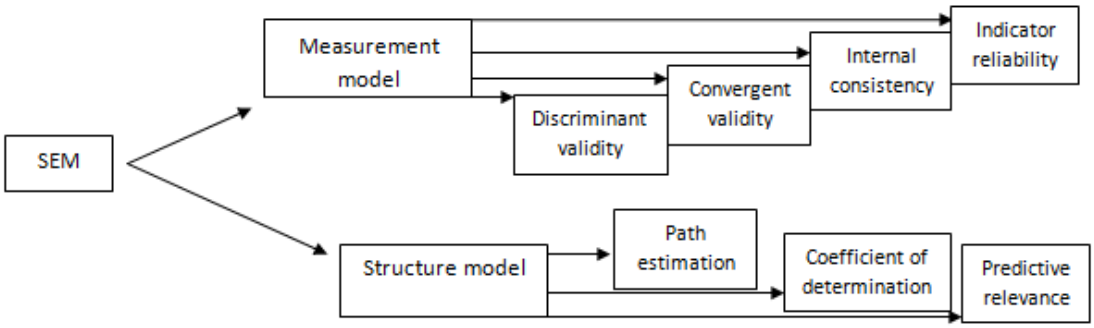

Figure 4.1: Process of structure equation modeling. *(Author's own)*

The PLS-SEM process typically involves two steps as shown in given figure:

- **Measurement Model:** This model is developed by establishment of a relationship among the latent constructs as well as the observed variables. This is done by estimating the discriminant validity, internal consistency, indicator reliability and convergent validity.
- **Structural Model:**This step explicates about estimating relationship of latent constructs. This is done by identifying the path estimation, coefficients of determination and predictive relevance.

4.3 Assessment of Measurement Model I

A part of the overall model that defines latent variables and determines construct validity is called the measurement model (Cavana et al., 2001; Churchill, 1979). On the other hand, "the evaluation of the extent to which it accurately measures what it is intended to measure" is referred to as construct validity (Hair et al., 2010; Malhotra, 2007; Chen andRaj, 2004). Evaluating the measurement model in SmartPLS-4.0

entails analyzing the measurement items' validity (convergent & discriminant) and reliability.

- **Reliability:** It means stability as well as consistency of the measurement items. Smart-PLS provides several measures of reliability, including factor loadings, Cronbach's alpha, and composite reliability (CR). It is acceptable if the Cronbach's alpha value is at least 0.7, and it indicates a high level of dependability if the CR value is at least 0.7. Moreover, the outer loading of each indicator item must be more than 0.70. (Hair et al., 2014).
- **Validity:** It represents show well the measuring items measure what they are intended to measure. SmartPLS-4 provides both (convergent and discriminant) validity measures.

Convergent validity: This means different aspects of the measurement align with one another or correlate with one another. SmartPLS-4 software provides two measures of convergent validity. The AVE (Average Variance Extracted) and factor loadings are also included in these measurements. According to Hair et al., (2014)'s analysis, the AVE values of either 0.5 or greater will reflect a good level of convergent validity in the research that has been done previously.

Discriminant validity: It essentially indicates required degrees of dissimilarity between the measured parts. SmartPLS-4 provides two discriminant validity measures: A) The Fornell-Larcker criterion and B) the heterotrait-monotrait ratio (HTMT). Applying the Fornell-Larcker criterion, the first stage entails comparing the sq. root of each construct's AVE to the inter-construct correlations. Thereafter HTMT compares the correlations between constructs with the correlations between their respective indicators. Both measures should be less than 0.9 to indicate good discriminant validity.

Overall, assessing the measurement model in SmartPLS-4 involves examination of validity (convergent & discriminant) and reliability of the measurement items.

Smart-PLS provides several measures to evaluate each of these aspects, and the recommended thresholds for acceptable performance can guide researchers in interpreting their results. On the basis of conceptual model, a model was framed in SmartPLS-4 as shown below:

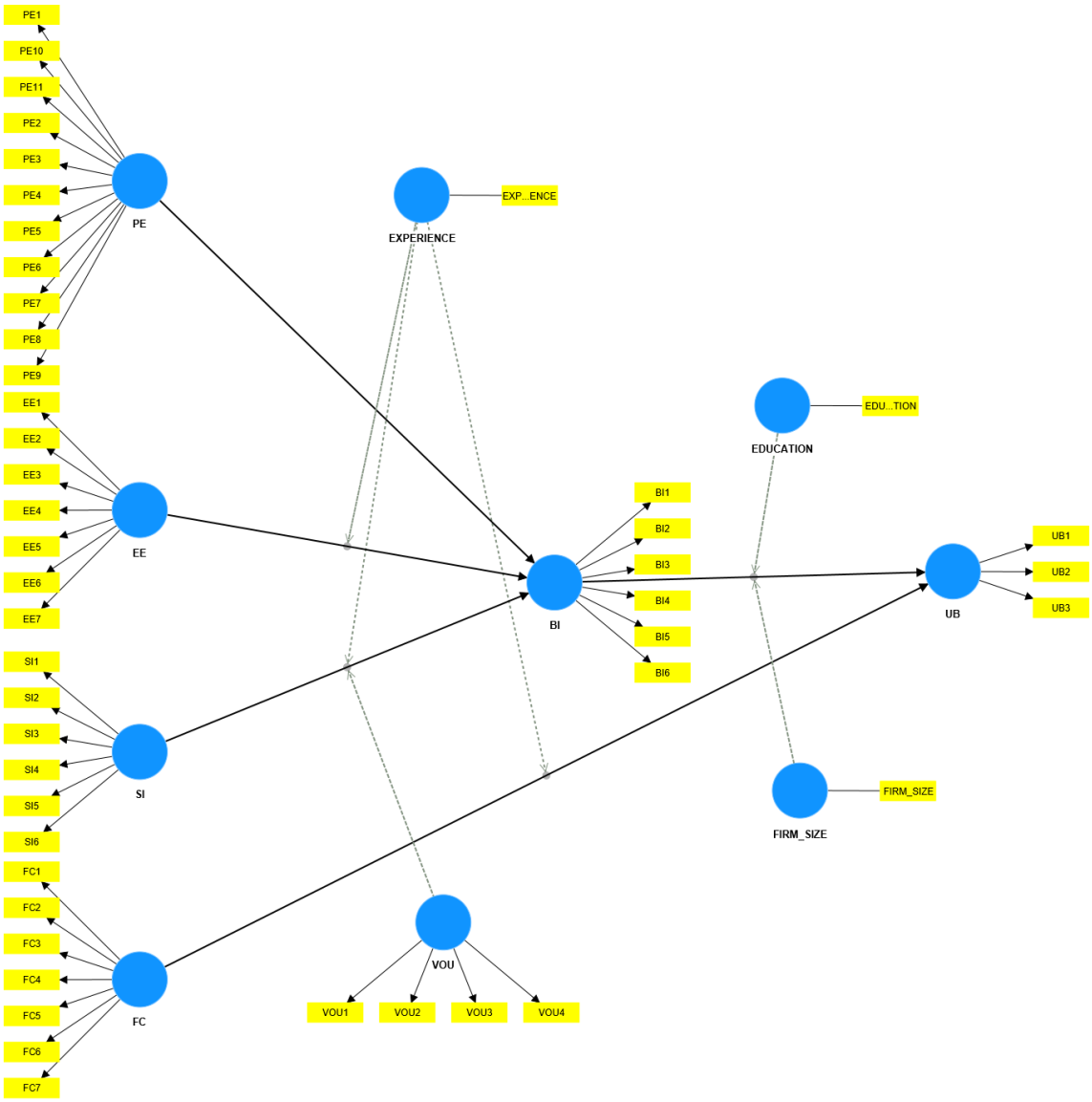

Figure 4.2: Measurement model 1.

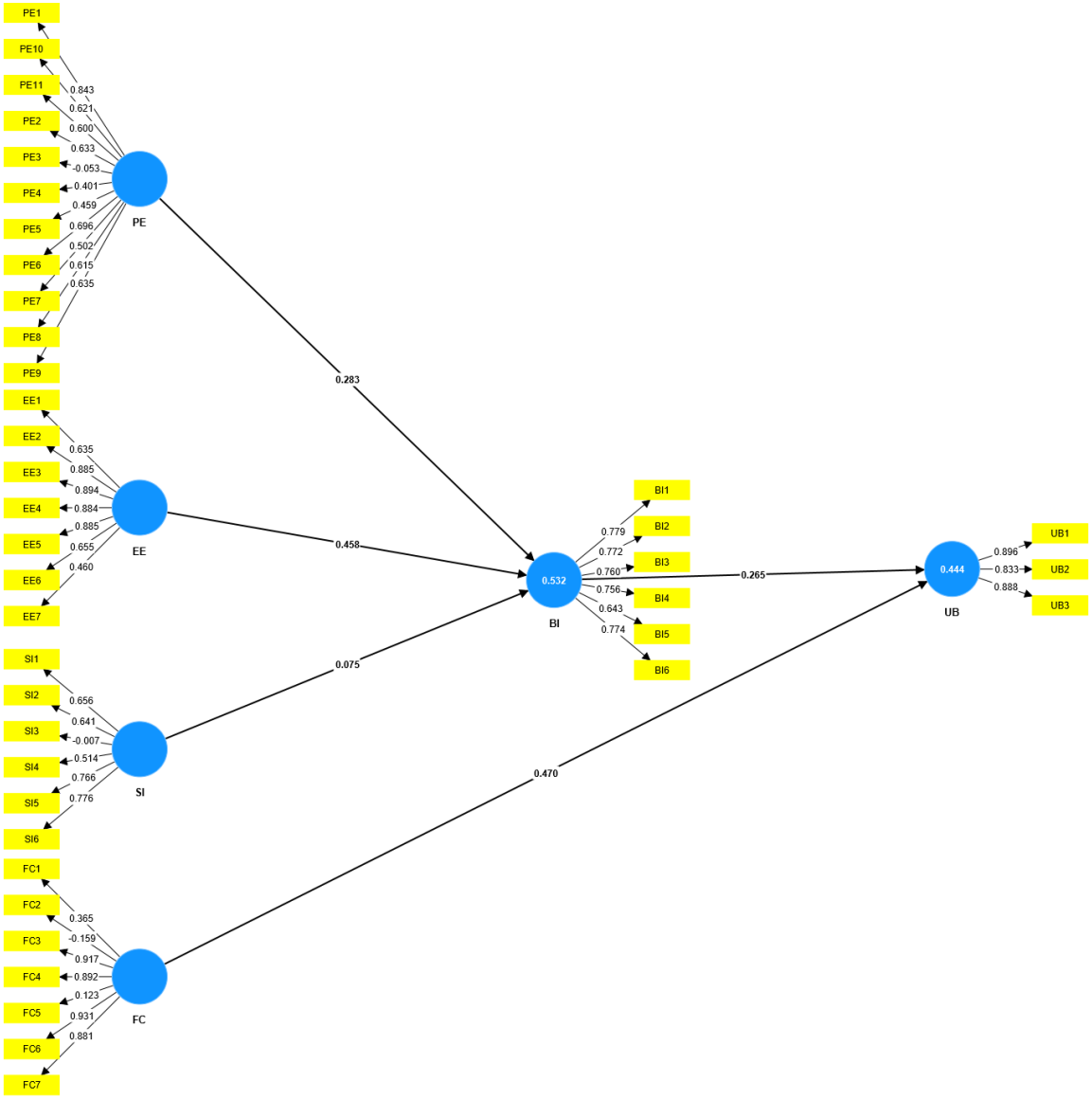

Figure 4.3: Measurement model excluding moderators (with values).

Given table demonstrate measurement model I's outer loading values.

Table 4.9: Out loadings of Measurement model-I.

CONSTRUCTS	ITEMS	LOADINGS
BEHAVIOR INTENTION	BI1	0.779
	BI2	0.772
	BI3	0.76

	BI4	0.756
	BI5	0.643
	BI6	0.774
EFFORT EFFICIENCY	EE1	0.635
	EE2	0.885
	EE3	0.894
	EE4	0.884
	EE5	0.885
	EE6	0.655
	EE7	0.46
FACILITATING CONDITION	FC1	0.365
	FC2	-0.159
	FC3	0.917
	FC4	0.892
	FC5	0.123
	FC6	0.931
	FC7	0.881
PERFORMANCE EXPECTANCY	PE1	0.843
	PE10	0.621
	PE11	0.6
	PE2	0.633
	PE3	-0.053
	PE4	0.401
	PE5	0.459
	PE6	0.696
	PE7	0.502
	PE8	0.615
	PE9	0.635
SOCIAL INFLUENCE	SI1	0.656
	SI2	0.641
	SI3	-0.007

	SI4	0.514
	SI5	0.766
	SI6	0.776
	UB1	0.896
	UB2	0.833
USE BEHAVIOR	UB3	0.888

(Source: Author's calculations)

In above table there are some items of different constructs whose outer loadings are below.7. Even some loadings are in minus. Christian M. Ringle (2017) stated that there is need to delete items with outer loadings below 0.4. If loadings are below 0.7, only delete them if necessary to increase the AVE above 0.4 and the composite reliability above 0.7.

In the below table items PE3, SI3 and FC1, FC2, FC5 are deleted, which were less than 0.4.

Table 4.10: After removing lading below 0.4.

CONSTRUCTS	ITEMS	LOADINGS
	BI1	0.779
	BI2	0.773
	BI3	0.76
	BI4	0.755
	BI5	0.643
BEHAVIOUR INTETION	BI6	0.774
	EE1	0.635
	EE2	0.885
	EE3	0.894
	EE4	0.884
	EE5	0.885
	EE6	0.655
EFFORT EXPECTANCY	EE7	0.46

FACILITATING CONDITION	FC3	0.922
	FC4	0.897
	FC6	0.936
	FC7	0.892
PERFORMANCE EXPECTANCY	PE1	0.842
	PE10	0.618
	PE11	0.596
	PE2	0.626
	PE4	0.426
	PE5	0.473
	PE6	0.703
	PE7	0.51
	PE8	0.612
	PE9	0.638
SOCIAL INFLUENCE	SI1	0.652
	SI2	0.639
	SI4	0.516
	SI5	0.767
	SI6	0.781
USE BEHVIOUR	UB1	0.896
	UB2	0.832
	UB3	0.888

(Source: Author's calculations)

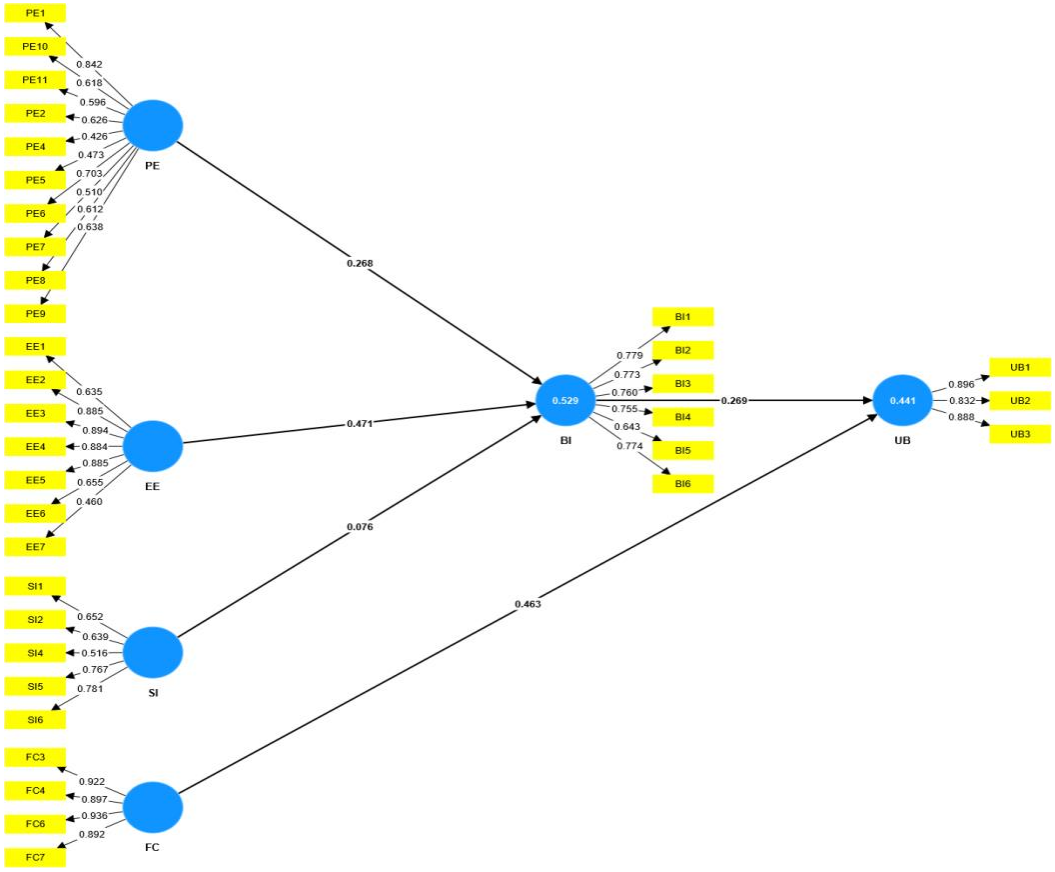

Figure 4.4: Measurement model II.

Internal Consistency Reliability

The initial stage in evaluating a measurement model is to examine its internal consistency. Internal consistency refers to the degree to which the individual items or questions that comprise a scale or questionnaire are related to one another.It pertains to how closely the scale's elements measure the same construct or idea. It is usual practice to evaluate reliability using statistical approaches such as Cronbach's alpha, that presents an assessment of reliability based on the correlation between markers (Shanmugpriya, 2016).Despite this, it does have one weakness, which is that it assumes all markers are equally dependable (Hair et al., 2011), which is not true. Because the items are not weighed, Cronbach alpha is less precise, which can reduce reliability (Yahaya et al., 2019; Raykov, 2007).

For this reason, another measure of reliability is used known as CR (Composite Reliability). It is used to check the reliability. Cronbach's alpha coefficient is a popular measure for calculating reliability and is frequently utilized while doing so. However, composite reliability is considered to be a more accurate and robust measure of internal consistency than Cronbach's alpha, especially when the items or measures have different levels of difficulty or discrimination.

Explicitly, Larker and Fornell (1981) define composite reliability as "the internal consistency of indicators that measure the underlying constituents." Yet, the gold standard for composite reliability is a value greater than.70, which indicates higher CR (Hair et al., 2010). In light of the foregoing, the CR can be computed automatically using software called Smart-PLS, or it can be calculated manually using the approach provided below:

$$CR \frac{\left(\sum_{i=1}^{n} Ei\right)^2}{\left(\sum_{i=1}^{n} Li\right)^2 + \left(\sum_{i=1}^{n} Li\right)}$$

Where:

L = Standardized factor loading

i = Number of the corresponding item

E = Error variance term for an item (Hair et al., 2010)

Convergent and Discriminant Validity: Validity of constructs can be examined by using discriminant validity as well as convergent validity. Meanwhile, Malhotra (2007) articulated convergent validity (CV) as “the extent that the instrument designed to measures the same construct and is related to each other”. For determining convergent validity, the AVE needs to be calculated by factoring the required indications associated with the respective constructs.Furthermore, the Smart-PLS 4 data analysis software computes the Average Variance Extracted value (AVE) for every construct. On the other hand, the AVE can be calculated manually using the formula, which is presented in the following form:

$$AVE = \frac{\sum_{i=1}^{n} Li^2}{n}$$

Where :

L = Standardised factor loading

I = Number of the corresponding item

Table 4.11: Table of threshold limits.

	Threshold limits	**References**
Cronbach's alpha	**>0.6**	Hair et al., 2009; Hair et.al., 2011; Hair et.al., 2014; Mouakket, 2012; Abdul Rehman et. al., 2013; Picon et.al., 2014; Shanmugapriya, 2016; Christino et.al., 2016; Jaggi, 2018; Narula, 2020
Composite Reliability	**>0.7**	Hair et.al., 2009; Hair et.al., 2011; Mouakket, 2012; Abdul Rehman et. al., 2013; Hair et.al., 2014; Picon et.al., 2014; Shanmugapriya, 2016; Christino et.al.,2016; Raheja, 2018; Al-Adwanand Al-Horani, 2019;
AVE	**>0.5**	Fornell & Larcker, 1981; Tenenhaus et. al., 2005; Hair et al., 2009; Henseler et. al., 2009; Picon et.al., 2014; Shanmugapriya, 2016; Jaggi, 2018; Yahaya, 2019; Al-Adwan& Al-Horani, 2019; Narula, 2020

(Source: Author's calculations)

Moreover, Convergent validity is stated as "the principle that the indicators for a given construct should be at least moderately correlated among them while discriminant validity implies the extent to which a given construct differs from other constructs." There are two common measures that are used to determine the convergent validity by using the PLS software are the CR as well as AVE methods. Specifically, AVE can be defined as "the amount of variance that is captured by the construct in relation to the amount of variance due to measurement error". If the value of AVE is less than required

value of 0.50, this indicates that the variation due to observational errors is greater than the variance overall (2) of the construct; accordingly, specific concept's validity and the corresponding indicators is in question (Fornell and Larcker, 1981). To meet the requirements of Convergent Validity (CV), it is important to account for the AVE value of each and every construct 50% of the overall amount of data fluctuation. In addition, convergent validity was studied by finding the path loadings of all items with a value greater than 0.50 that was statistically significant (Hair et al., 2010).It is essential to take into consideration that if Composite Reliability is >0.70 then the reliability is found to be a suitable indicator for the good Convergent Validity. According to the findings of Composite Reliability, the values of CR for all of the constructs are higher than the indicated range of.70 (Hair et al., 2010). When the Composite Reliability value is more than the AVE and when the AVE of each component is larger than.50, convergent validity has been proven (Hair et al., 2006).

Table 4.12: Internal Consistency & Convergent Validity of Measurement Model II

Convergent Validity and Internal Consistency				
	Cronbach's alpha	**Merged reliability (rho_a)**	**Merged reliability (rho_c)**	**Average variance extracted (AVE)**
BI	0.851	0.87	0.884	0.561
EE	0.878	0.91	0.909	0.598
FC	0.834	0.933	0.895	0.668
PE	0.813	0.84	0.854	0.378*
SI	0.701	0.713	0.806	0.459*
UB	0.844	0.861	0.905	0.761

(Source: Author's calculations)

(Note: UB=Use Behavior, BI=Behavior Intention, PE=Performance Expectancy, EE=Effort Expectancy, SI=Social Influence, FC=Facilitating Condition, *= poorly fitted construct)

In given table of Internal Consistency & Convergent Validity of Measurement Model II, AVE value of Performance Expectancy and Social influence is <0.5, which indicate that there is need to delete some items of given constructs.

4.4Assessment of Measurement Model III

After removing seven indicators (PE4, PE5, EE7, SI4, FC1, FC2, and FC5) from various constructs, a new PLS SEM model was constructed and examined once more. To choose the right model, the discriminant validity, convergent validity, and internal consistency and were examined once more.

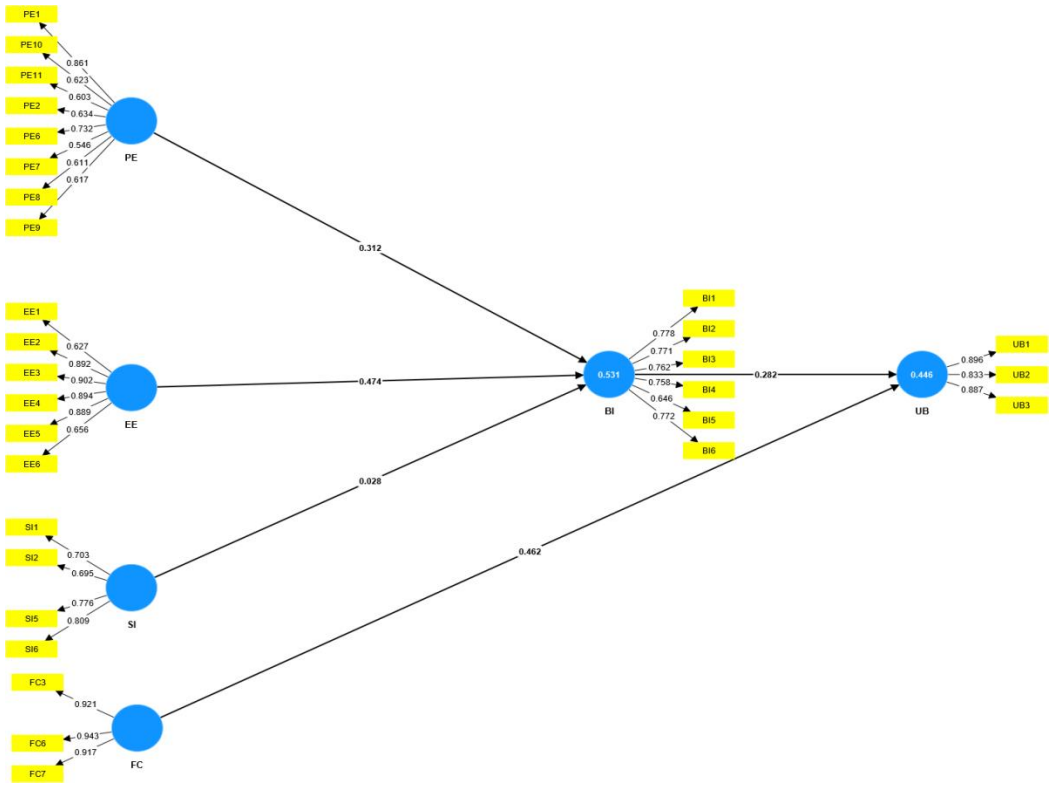

Figure4.5: Measurement model III

In accordance with what was discussed before in relation to the measurement model III, all of the elements' threshold limits are investigated. In above measurement model III conditions of internal consistency and convergent validity do not met. There are still poor fitted indicators which are impacting AVE value of Performance Expectancy. In given table PE value is 0.435, which should be >0.5.

Table 4.13: Internal Consistency & Convergent Validity of Measurement Model III

INTERNAL CONSISTENCY AND CONVERGENT VALIDITY				
	Cronbach's alpha	**Composite reliability (rho_a)**	**Composite reliability (rho_c)**	**Average variance extracted (AVE)**
BI	0.851	0.868	0.884	0.562
EE	0.878	0.91	0.909	0.598
FC	0.918	0.918	0.948	0.859
PE	0.811	0.828	0.858	0.435*
SI	0.743	0.762	0.835	0.559
UB	0.844	0.86	0.905	0.761

(Note: UB=Use Behavior, BI=Behavior Intention, PE=Performance Expectancy, EE=Effort Expectancy, FC=Facilitating Condition, SI=Social Influence, *= poorly fitted construct)

Therefore, once again some poorly fitted indicators need to delete. The lowest values will be deleted.

4.5Assessment of Measurement model IV

In order to obtain the necessary Average Variance Extracted value of PE; several poorly fitting values (PE11, PE8, and PE9) of the construct Performance Expectancy have been

eliminated. After that, a new PLS SEM model was constructed and analyzed once more. To choose the right model, the discriminant validity, internal consistency, and convergent validity is examined once more.

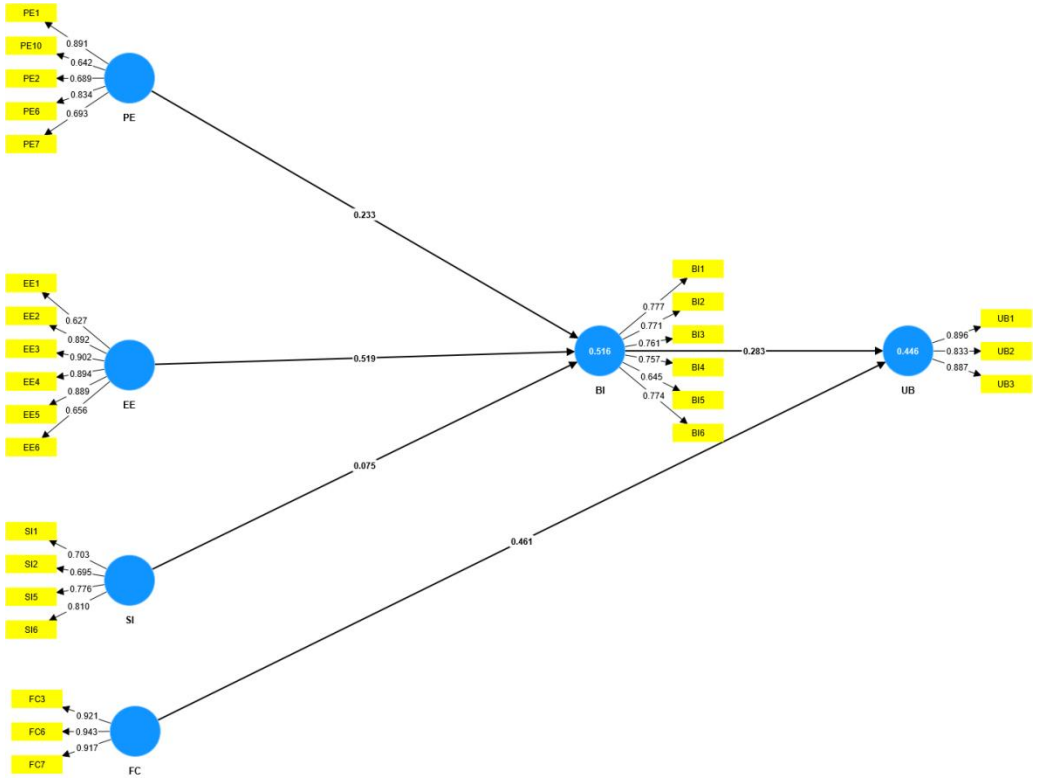

Figure4.6: Measurement model IV.

The following table shows the convergent validity& internal consistencyof measurement model IV. All of the threshold restrictions have been met when the composite reliability is better than 0.7, the average variance extracted is greater than 0.5, and the Cronbach alpha is greater than 0.6.It signifies that of measurement model IV is internally consistent and convergent validity is also well proven.

Table 4.14: Internal Consistency & Convergent Validity of Measurement Model IV

INTERNAL CONSISTENCY AND CONVERGENT VALIDITY				
	Cronbach's alpha	**Composite reliability (rho_a)**	**Composite reliability (rho_c)**	**Average variance extracted (AVE)**
BI	0.851	0.87	0.884	0.561
EE	0.896	0.915	0.923	0.67
FC	0.918	0.918	0.948	0.859
PE	0.811	0.851	0.868	0.571
SI	0.743	0.762	0.834	0.559
UB	0.844	0.86	0.905	0.761

(Note: UB=Use Behavior, BI=Behavior Intention, PE=Performance Expectancy, SI=Social Influence, EE=Effort Expectancy, FC=Facilitating Condition, *= poorly fitted construct)

Discriminant Validity: It outlines how different or discriminant each concept is from the others. In other words, it gives a hint that the construct is unique and that it capture phenomena that is not covered by another construct in the model that is subsequently suggested. To know the discriminant validity fornell-larker (1981) criterion shall be used (Hair et. al.,2011;Henseler et. al., 2009; Narula,2020; Yahaya et. al.,2019)

Finding appropriate discriminant reliability, the following conditions are to be fulfilled:

1. AVE shall be greater than 0.5
2. The AVE of an individual construct's (values in bold) square root must be higher than the construct's relationship to other elements for this to be valid (off-diagonal values)

The discriminant validity must be established once the internal consistency and convergent validity have been established.In the following table, the discriminant validity of the constructs is proved. The values on the diagonal, which are shown in bold,

represent the square root of the AVE calculated in the table that is just displayed, whilst the values that are not on the diagonal represent the correlation between the various components.

Table4.15: Discriminant validity of Measurement Model IV

Discriminant Validity							
	AVE	BI	EE	FC	PE	SI	UB
BI	0.561	**0.74899933**					
EE	0.67	0.719	**0.81853527**				
FC	0.859	0.605	0.861	**0.926823**			
PE	0.571	0.59	0.568	0.493	**0.755645**		
SI	0.559	0.515	0.624	0.715	0.496	**0.747663**	
UB	0.761	0.6	0.689	0.702	0.44	0.585	**0.872353**

(Source: Author's calculations)

(Note: UB=Use Behavior, PE=Performance Expectancy, SI=Social Influence, BI=Behavior Intention, EE=Effort Expectancy, FC=Facilitating Condition, *= poorly fitted construct)

In the measurement model IV, the first condition is satisfied but not the second one. Therefore, in order to satisfy the condition, some items are required to be deleted. It is necessary to identify the construct for which the AVE (square root) of the individual constructs (bold values) does not exceed the correlation of the construct with other elements (off-diagonal values).

4.6Assessment of Measurement model-V

After observing measurement model IV, 2 indicators (EE1 and EE6) from construct Effort Expectancy are removed. In order to select the best model, the discriminant

validity, the internal consistency, and the convergent validity are all double-checked. After a second round of inspection, it was determined that all of the criteria for internal consistency and convergent validity have been satisfied. This conclusion is reached after the threshold limits of all of the components are reevaluated. To determine the legitimacy of the discriminant, another calculation of the square root of the AVE values are conducted. This time, the second condition of establishing discriminant validity is also satisfied.

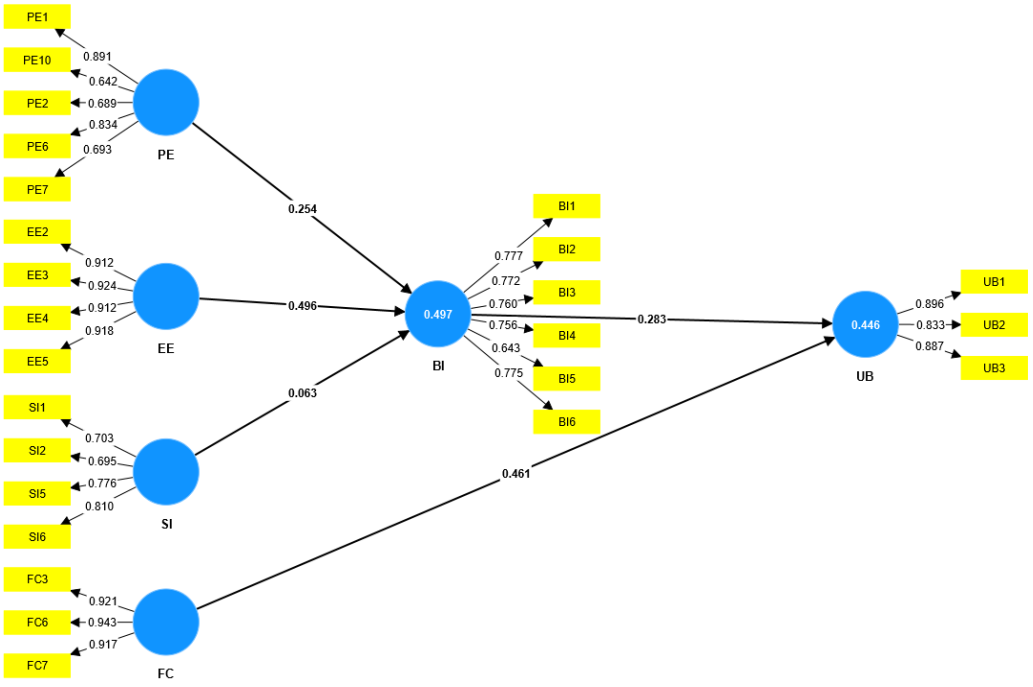

Figure 4.7: Measurement model V.

The following table shows measurement model V's outer loadings.

Table4.16: measurement model V's outer loadings.

Constructs	Items	Loadings
Performance	PE1	0.891

Expectancy	PE10	0.642
	PE2	0.689
	PE6	0.834
	PE7	0.693
Effort Expectancy	EE2	0.912
	EE3	0.924
	EE4	0.912
	EE5	0.918
Social Influence	SI1	0.703
	SI2	0.695
	SI5	0.776
	SI6	0.81
Facilitating Condition	FC3	0.921
	FC6	0.943
	FC7	0.917
Behaviour Intention	BI1	0.777
	BI2	0.772
	BI3	0.76
	BI4	0.756
	BI5	0.643
	BI6	0.775
Use Behaviour	UB1	0.896
	UB2	0.833
	UB3	0.887

(Source: Author's calculations)

The following table shows the internal consistency and convergent validity of measurement model V. It is possible to detect that the Cronbach alpha value exceeds 0.6. All threshold requirements are satisfied when paired with an AVE larger than 0.5 and a

composite dependability better than 0.70.It signifies that of measurement model V is internally consistent and convergent validity is also well proven.

Table4.17: Internal Consistency and Convergent Validity of Measurement Model V.

INTERNAL CONSISTENCY AND CONVERGENT VALIDITY				
	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
BI	0.851	0.87	0.884	0.561
EE	0.936	0.937	0.954	0.84
FC	0.918	0.918	0.948	0.859
PE	0.811	0.851	0.868	0.571
SI	0.743	0.762	0.835	0.559
UB	0.844	0.86	0.905	0.761

(Source: Author's calculations)

(Note: UB=Use Behavior, BI=Behavior Intention, PE=Performance Expectancy, EE=Effort Expectancy, FC=Facilitating Condition, SI=Social Influence, *= poorly fitted construct)

The following table 4.18 shows the discriminant validity of measurement model V. Both the conditions of discriminant validity are fulfilled thereby it can be said that final model has been framed.

Table 4.18: Discriminant validity of Measurement Model V

Discriminant Validity							
	AVE	BI	EE	FC	PE	SI	UB
BI	0.561	**0.748999**					
EE	0.84	0.684	**0.916515**				

FC	0.859	0.605	0.86	**0.926823**			
PE	0.571	0.59	0.549	0.493	**0.755645**		
SI	0.559	0.515	0.664	0.715	0.496	**0.747663**	
UB	0.761	0.6	0.695	0.702	0.44	0.585	**0.872353**

(Source: Author's calculations)

(Note: UB=Use Behavior, BI=Behavior Intention, EE=Effort Expectancy, SI=Social Influence, PE=Performance Expectancy, FC=Facilitating Condition)

4.7Structural model

The present research work has adopted two-step process to achieve its objectives. The first step includes estimating and validating measurement model (outer model) (Hair etal., 2011). The results of the measuring model have demonstrated that it has a level of reliability as well as convergent validity and discriminant validity that are all satisfactory. And therefore, as a result, the suggested conceptual model is supposed to be accepted. The subsequent step is to evaluatethe results of inner model (also called structural model) (Yahaya et. al., 2019). The structural model is helpful in both comprehending the link between the components and taking into account the indirect and direct influences that one structure has on the others (Hair et al., 2011). While conducting research and testing theories, the structural model is a useful resource. This allows the researcher to continue with the structural model (inner model), evaluate the mediation impact, and test hypotheses (Narula, 2020). Testing the structural relationships between constructs and reviewing how well the model fits the data are both part of the evaluation of structural models.

For evaluating structural model, Multicollinearity, Amount of variance (R^2), path coefficients and Goodness of Fit (GoF) (Shanmugapriya, 2016; Al-Adwan& Al-Horani, 2019) are to be assessed.

Multicollinearity: Yahaya et al., (2019 advocated that Multicollinearity be evaluated for thorough evaluation of model. In the inner structural model, it shall be noticed that each set of independent variables is checked with the aid of the SmartPlS-4 software. The value of the Variance Inflation factor (VIF) should be less than 5, as stated in Hair et al. (2013).

Table4.19: Colliniarity table of items.

Items	VIF
BI1	1.949
BI2	1.819
BI3	4.342
BI4	4.71
BI5	2.322
BI6	1.658
EE2	3.365
EE3	4.131
EE4	3.521
EE5	3.867
FC3	3.243
FC6	4.057
FC7	3.015
PE1	3.351
PE10	1.322
PE2	1.406
PE6	4.48
PE7	2.979
SI1	1.766
SI2	1.749
SI5	1.504

SI6	1.573
UB1	2.472
UB2	1.867
UB3	2.022

(Source: Author's calculations)

In the above table VIF values of different items are below 5. The threshold limit is met and it implies that there is no problem of Colliniarity.

Coefficient of determination (R^2): The predictive power of the model is verified while observing coefficient of determination i.e., R-square. It represents the fusion of the effects of exogeneous constructs on endogenous constructs (Christino et. al.,2019). R^2 indicates the predictive power in structural model (Narula, 2020). Wherefore, the values of 0.19, 0.33 and 0.67 are considered as feeble, modest and considerable power correspondingly (Chin, 1998; Shanmugapriya, 2016; Narula, 2020; Tenenhaus et.al., 2005). If there are 1 or 2 exogeneous variables, moderate value of R^2 is acceptable but if variables are more than 2 in that case R^2 shall be of substantial level (Henseler et. al., 2009; Shanmugapriya, 2019). And if R^2 values are weak, it implies that the model is not capable of explaining the endogenous or dependent variables appropriately. In the present research, the R^2 values for different constructs are 0.497 (moderate) and 0.446 (moderate).

Table 4.20: Coefficient of determination (R^2)

Construct	R^2
Performance Expectancy	-
Effort Expectancy	-
Social Influence	-
Behavior Intention	0.497
Facilitating Condition	-
Use behavior	0.446

(Source: Author's calculations)

Predictive relevance: After Coefficient of determination (R^2) researcher should asses value of Q^2 (Stone,1974). This value indicates the relevance of prediction of model. Data which was not utilized in estimation of the model, is predicted with accuracy when relevancy in prediction is exhibited by the model. When it comes to structural model, if value of $Q^2$for a certain dependent latent construct which is reflective is greater than zero, it indicates predictive relevance of the model for that variable. Threshold value for $\mathbf{Q^2}$value suggested by chin (1998) are 0.35, 0.15 and 0.2 which depicts high, medium and low effect respectively.

Table 4.21: Predictive relevance value (Q^2)

Endogenous latent constructs	**Q^2**
BI	.25
UB	.328

(Source: Author's calculations)

GoF: Wetzels and Cohen et al. (2009) discovered that the minimum effect size, also known as the GoF(goodness of fit), it should be 0.10, 0.25, and 0.30 for tiny, medium, and significant effects on the endogenous variable, respectively, and the minimum AVE must be more than 0.50. (Fornell, 1981). The suitable GoF, according to Tenenhaus et al. (2005) and Wetzels, Van Oppen and Odekerken Schroder (2005), can be calculated by taking the square root of the product of the mean AVE (average variance extracted) and the mean R2. The GoF was judged to be 0.570, with a minimum AVE of 0.559. As a result, if all preconditions are met, the effect size is significant (more than 0.30).

$$GoF = \sqrt{Average\ AVE \times Average\ R^2}$$ (Uddin et al., 2020)

$$GoF = \sqrt{Average\ AVE \times Average\ R^2}$$

$$GoF = \sqrt{.691 \times .472}$$

GoF=.570

Path coefficients (Hypothesis testing): Hypothesis testing is based on path coefficient values and is the second most important aspect of evaluating structural model after R^2. Path coefficients represent the relationships among independent (exogenous) and dependent (endogenous) variables. Hypothesis framed are accepted or rejected on the basis of R^2 and t-statistics values. The researcher has already calculated and approved R^2 values. In order to find out t-statistics values, bootstrapping process was run in SmartPLS-4.The assessment of structural model (inner model) is done with bootstrapping technique as elaborated in the below section:

4.8Bootstrap simulation

Path coefficients (Hypothesis testing): Hypothesis testing is based on path coefficient values and is the second most important aspect of evaluating structural model after R^2. Path coefficient represents the relationships among independent (exogenous) and dependent (endogenous) variables. Hypothesis framed are accepted or rejected on the basis of R^2 and t-statistics values. The researcher has already calculated and approved R^2 values. In order to find out t-statistics values, bootstrapping process was run in SmartPLS-4.0.The assessment of structural model (inner model) is done with bootstrapping technique as elaborated in the below section.

The bootstrap algorithm is calculated under PLS-SEM. PLS-SEM does not presume normal distribution of data therefore, bootstrap process is applied which means “repeated random sampling (with replacement) from original sample to create bootstrap sample”. After that, the standard error is calculated so that it can be utilized during the process of evaluating the given hypothesis. Likewise, the bootstrapping procedure operates under the presumption that the sample distribution accurately reflects the expected distribution

of the population (Hair et. al.,2011; Davison & Hinkley, 1997). In their study, Henseler et al., (2009) concluded that utilizing a bootstrap sample in this manner permits the significance of estimated coefficients to be examined (Hair et. al., 2011).

One can analyze the significance of the path coefficient and t-statistic values using bootstrap methods, which generate 5000 samples from the original data(Henseler et. al.,2009; Hair et. al., 2011; Shanmugapriya, 2016; Yahaya et. al., 2019; Al-Adwin and Al-Horani, 2019; Narula, 2020).In SmartPLS-4 software, while carrying out bootstrapping, the sample size is denoted as "cases" and bootstrap subsamples are denoted as "samples" which are taken as 5000 in order to generate appropriate and reliable results (Yahaya et. al., 2019). To check the significance of data, t-statistics values are calculated and observed. The t-values shall be more than 1.96 at 5% level of significance to verify substantial association among constructs (Tenehaus et. al., 2005; Yahaya et. al., 2019; Narula, 2020).

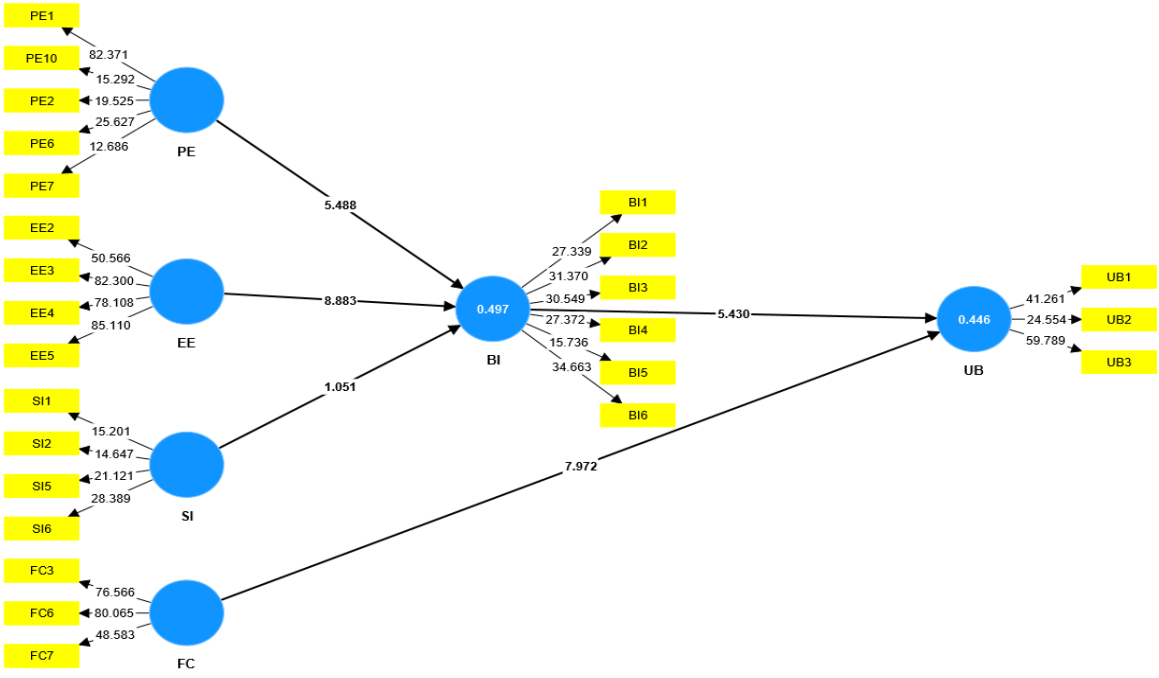

Figure4.8: Bootstrapping model (with values)

4.9 Hypothesis testing

Hypotheses testing have been done by performing bootstrapping. The following hypotheses have been framed for testing:

Table4.22: Hypothesis

Relationship	Hypotheses	
Performance Expectancy ->Behaviour Intention	H_1	Performance Expectancy significantly impacts Behavior Intention.
Effort Expectancy ->Behaviour Intention	H_2	Effort Expectancy significantly impacts Behavior Intention.
Social Influence ->Behaviour Intention	H_3	Social Influence significantly impacts Behavior Intention.
Facilitating Conditions ->Use Behaviour	H_4	Facilitating Conditions Significantly impactsUse Behaviour.
Behaviour Intention->Use Behaviour	H_5	Behaviour Intention significantly impacts Use Behaviour.

Based on values retrieved by bootstrap simulation, the following results are obtained:

Table 4.23: Hypothesis testing results.

Hypotheses testing					
		Original sample (O)	**T statistics (|O/STDEV|)**	**P values**	**Empirical Calculations**
H_1	PE -> BI	0.254	5.488	0	Accepted
H_2	EE -> BI	0.496	8.883	0	Accepted
H_3	SI -> BI	0.063	1.051	0.293	Rejected

H_4	FC -> UB	0.461	7.972	0	Accepted
H_5	BI -> UB	0.283	5.43	0	Accepted

H_1: Performance expectancy significantly impacts behavior intention.

The decision regarding acceptance or rejection of alternative hypothesis is taken on the basis of t-value and p-value (accepted level of significance as 5%). The t-value in the present relationship is 5.488. Hence, $H_1$is **accepted** as outcome value has a significant impact on behavior intention as t-value is more than1.96.It indicates that consumers think that using Zzk technology would improve productivity or simplify processes.

H_2: Effort expectancy significantly impacts behavior intention.

The decision regarding acceptance or rejection of alternative hypothesis is taken on the basis of t-value and p-value (accepted level of significance as 5%). The t-value in the present relationship is 8.883. Hence, H_2 is **accepted** as outcome value has a significant positive impact behavior intention as t-value is more than1.96.Results show that users' attitudes and intents towards embracing and utilizing technology are strongly influenced by their level of effort anticipation. When consumers perceive that a technology isso simple that it required low-effort to use, they are more likely to accept and integrate it into their daily lives. But, regardless of the technology's possible advantages, people are less inclined to accept it if they think it is hard to operate.

H_3: Social influence significantly impacts behavior intention.

The decision regarding acceptance or rejection of alternative hypothesis is taken on the basis of t-value and p-value (accepted level of significance as 5%). The t-value in the present relationship is 1.051. Hence, H_3 is **rejected** as process value does not have a significant positive impact on behavior intention as t-value is less than1.96.In contrast to past results social influence does not impact behavior

intention of user of green technology. It means that people do not have any interest to know about technology used in brick kiln firms.

H_4: Facilitating conditions significantly impact use behaviour.

The decision regarding acceptance or rejection of alternative hypothesis is taken on the basis of t-value and p-value (accepted level of significance as 5%). The t-value in the present relationship is 7.972. Hence, H_4 is **accepted** as outcome value has a significant positive impact on use behavior as t-value is more than1.96.According to result, facilitating conditions are very important in determining how people use technology. Users are more likely to engage with the technology and make full use of it when these conditions are favorable.

H_5: Behaviour intention significantly impact use behaviour.

The decision regarding acceptance or rejection of alternative hypothesis is taken on the basis of t-value and p-value (accepted level of significance as 5%). The t-value in the present relationship is 5.43. Hence, H_5 is **accepted** as outcome value has a significant positive impact on use behavior as t-value is more than1.96.

According to the path coefficients, it has been discovered that performance expectancy, facilitating conditions, and effort expectancy all positively associate with behavior intention. While social influence does not have a positive link with behavior intention. Behavior intention has also positive relationship with use behavior. R^2 for the proposed research model is 0.497 (moderate) for behavior intention and 0.446 (moderate) for use behavior. Further, Q2 value calculated for the BI and UB are respectively .25 and .328, which shows the BI and UB high impact corresponding to predictive relevance.Given the aforementioned findings, it is possible to conclude that the proposed research model is appropriate and acceptable (Narula, 2020; Tenenhaus et. al., 2005).

4.10 Moderation

The term "moderation" in statistics refers to a relationship between two or more variables in which the effect of one variable on a result is determined by the degree or value of another variable. In other words, the influence of one variable on a result is tempered by the influence of another. To put it another way, the connection between two variables can be influenced by a third variable to varying degrees. For example, let's say we are interested in studying the relationship between exercise and weight loss. We might also suspect that the effect of exercise on weight loss depends on a person's age. In this case, age would be the moderator variable. To analyze moderation, researchers typically use regression analysis. They look at how the outcome variable is affected by the predictor variable (exercise) and the moderator variable (age) and how those two variables interact with one another (weight loss).In statistical analysis, moderation can be a key feature to examine, as it can help us better understand the relationship between variables and identify subgroups of individuals who may benefit more or less from a given intervention or treatment. In their study, Baron et al., (1986) stated that moderation's investigation make important judgment about the state of existence of a relation between endogenous and exogenous.

Moderation of Experience

When Oliveira and Baptista (2015) and Venkatesh et al. implemented the UTAUT model, they focused primarily on participants' degrees of experience as the moderating variable (2012). According to Coffman (2014), users usually base their goals on the knowledge they've gained from interacting with similar technology in the past.

The research study's purpose is to look into how experience working as a moderator might alter effort expectancy, performance expectancy, and facilitating conditions. The following table presents the findings of the experience-related hypotheses for your perusal and consideration.

H6 There is a significant impact of experience as moderator between SI

(social influence) and BI (behavior intention).

A hypothesis is tested using bootstrapping technique in SmartPLS-4 software. The decision regarding acceptance or rejection of hypotheses is taken on the basis of t-value and p-value (accepted level of significance as 5%).

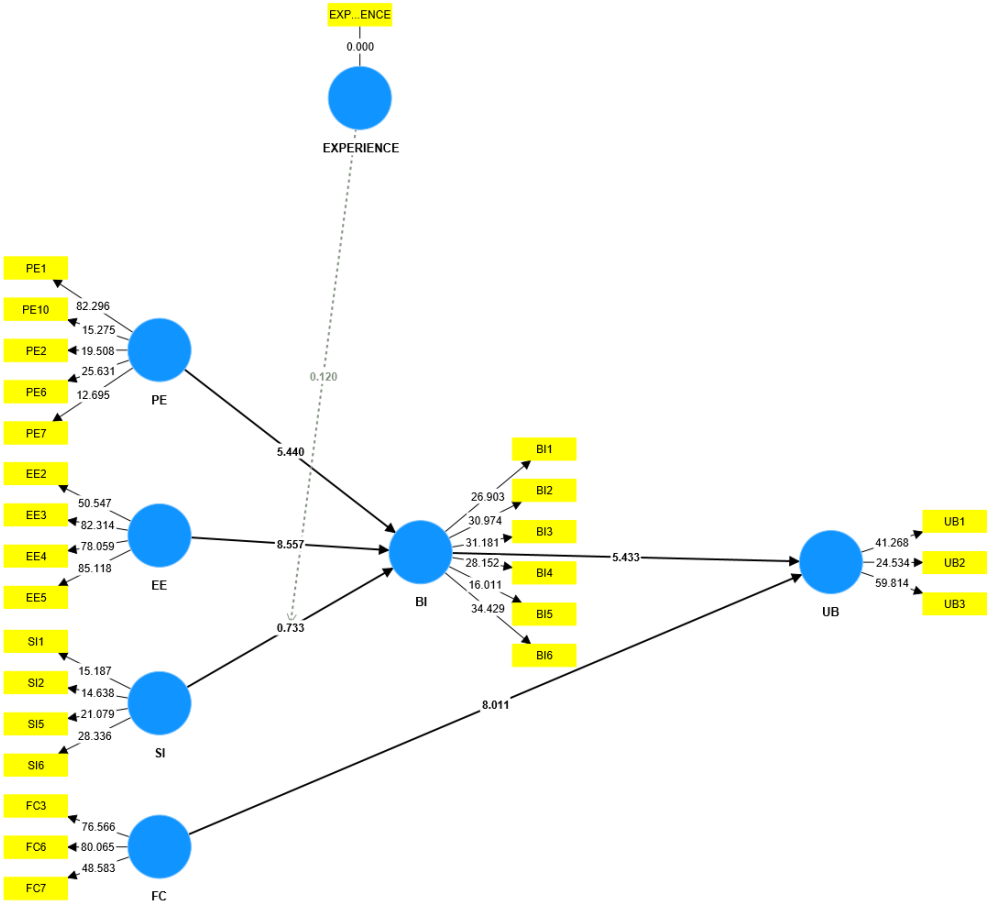

Figure 4.9: Moderation of experience between SI (social influence) and (BI) behavior intention.

The result shows that the t-value in the present relationship is .120. Hence, H_6 is **rejected** as outcome value does not havesignificant positive impact between social influence and behavior intention as t-value is less than1.96.Ultimately, experience can still affect social influence and behaviour intention through a variety of

processes, including knowledge acquisition, adaptation, individual differences, social learning, and situation specificity, even though it may not always have a clear-cut or direct impact on these variables.

H7: **There is a significant impact of experience as moderator between EE (effort expectancy) and BI(behavior intention).**

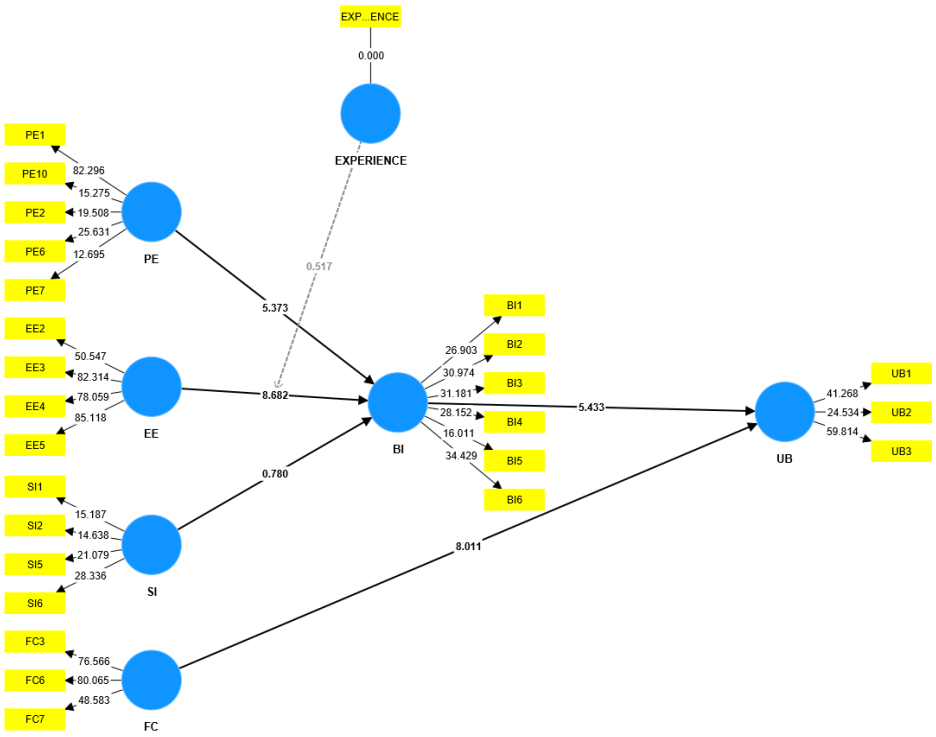

Figure 4.10: Moderation of experience EE (effort expectancy) and BI (behavior intention).

In order to validate the importance of the aforementioned hypotheses, a bootstrapping is conducted in SmartPLS4 on Moderation Hypothesis H7.

The result shows that the t-value in the present relationship is .517. Hence, H_6 is **rejected** as outcome value does not have significant positive impact betweenthe effort expectancy

and behavior intention as t-value is less than1.96.It implies that regardless of experience level, the perceived ease of executing an activity (effort expectancy) significantly impactsone's intention to engage in that behaviour. This is consistent with the idea that experience does not moderate effort expectancy and behaviour intention.

H8: **There is a significant impact of experience as moderator between FC (facilitating conditions) and BI (behavior intention).**

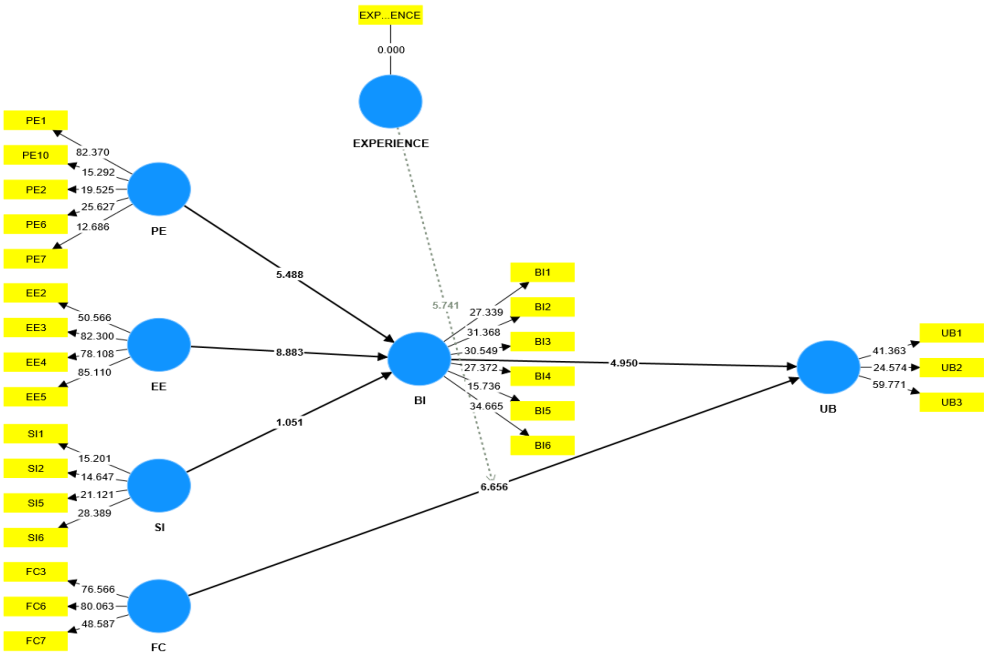

Figure 4.11:Moderation of experience between FC (facilitating conditions) and UB (use behavior).

To check the significance of above hypotheses H8 for moderation is analyzed using bootstrapping in SmartPLS4.

The result shows that the t-value in the present relationship is 5.741. Since the t-value is higher than 1.96, H8 is accepted as the outcome value with a considerable positive impact

on use behavior and facilitating conditions. Result implies that experience as a moderator positively impact the relationship between use behavior and facilitating conditions, which means that individuals with more experience significantly impact the relationship between facilitating conditions and use behavior.

H9: **There is a significant impact of voluntariness of use as moderator between SI (social influence) and BI (behavior intention).**

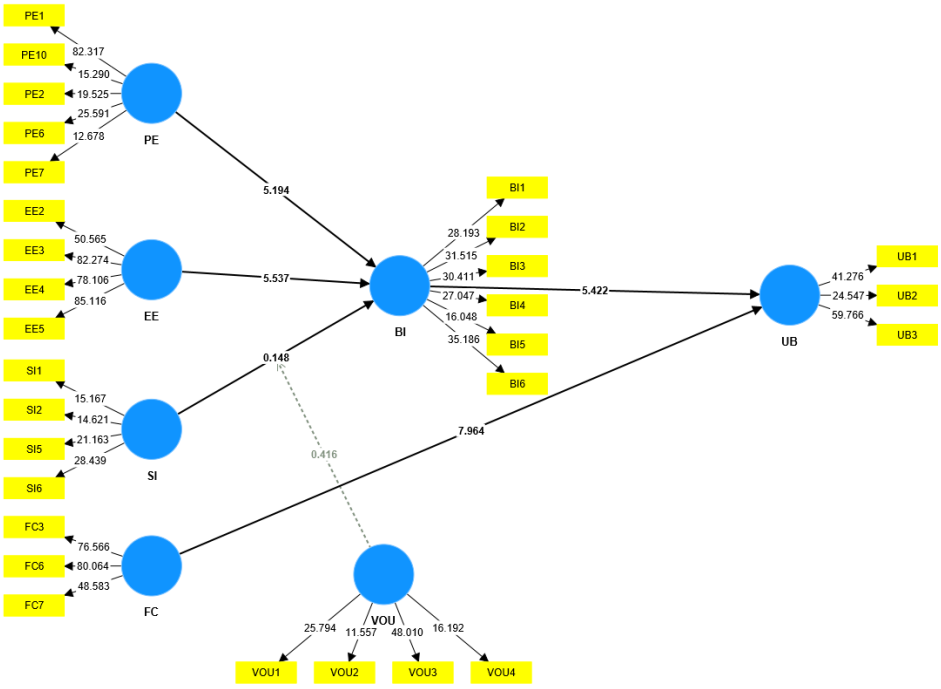

Figure 4.12: Moderation of voluntariness of use between SI (social influence) and (behavior intention).

In order to verify the significance of the hypotheses presented above, a bootstrapping step is performed in SmartPLS4 on Hypothesis 9 regarding moderation.

The result shows that the t-value in the present relationship is .416. Hence, H8 is rejected because the t-value is less than 1.96, indicating that the outcome value has no substantial positive impact on behavior intention and social influence.

H10: **There is a significant impact of Education as moderator between BI (behavior intention) and UB (use behavior).**

In order to determine whether or not the hypotheses under consideration are relevant, the H9 model for moderation was bootstrapped and analyzed using SmartPLS4.

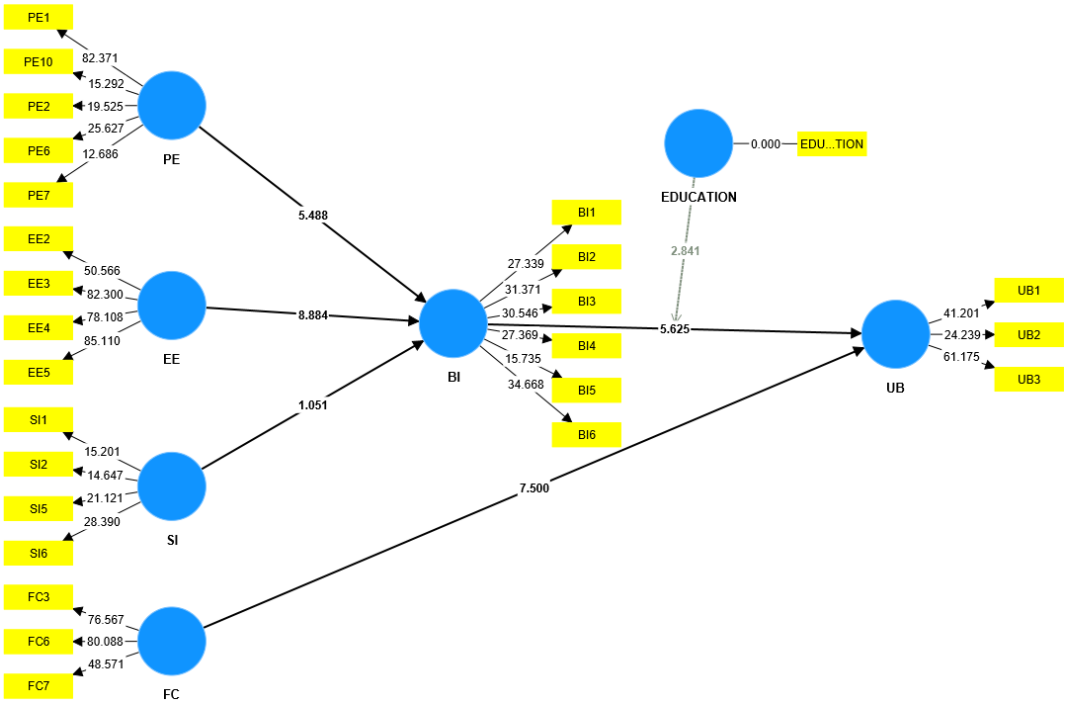

Figure 4.13: Moderation of education between BI (behavior intention) and UB (use behavior).

The result shows that the t-value in the present relationship is 2.841. Hence, $H_{10}$is **accepted** as outcome value do not have significant positive impact between behavior intention and use behavior as t-value is less than1.96.It means that, as compared to uneducated people, the educated employees or employer are more interested to use green technology.

H11: **There is a significant impact of Firm Size as moderator between BI (behavior intention) and UB(use behavior).**

H9 is evaluated using bootstrapping in SmartPLS4 to determine the relevance of the aforementioned hypotheses.

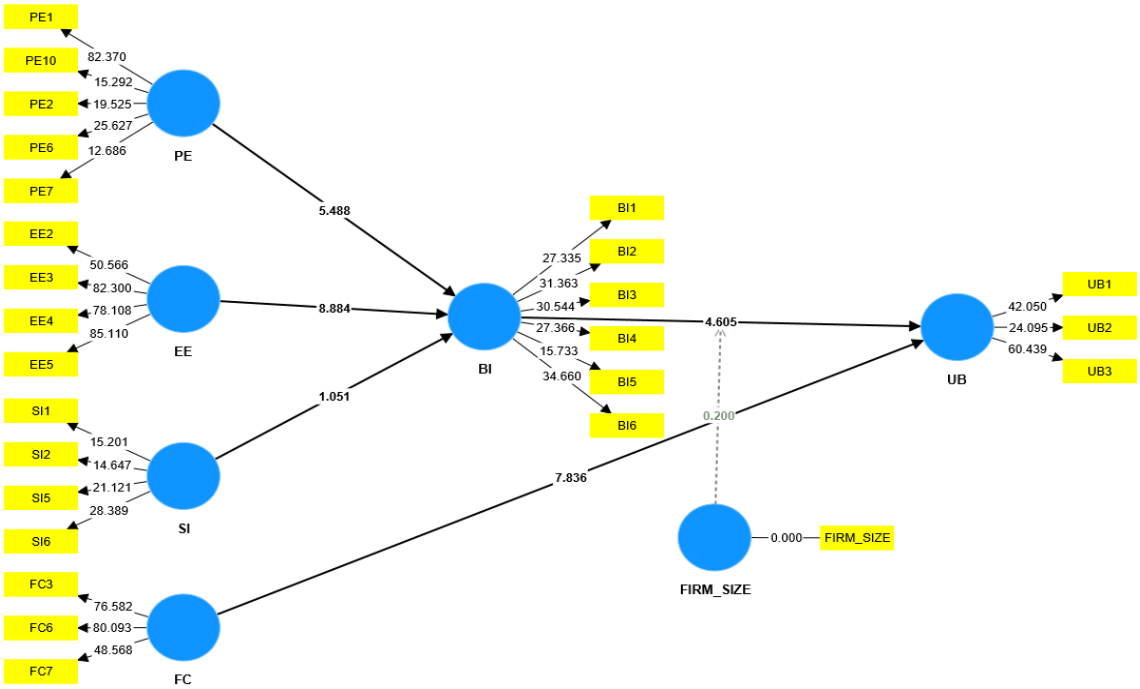

Figure 4.14: Moderation of firm size between BI (behavior intention) and UB(use behavior).

The result shows that the t-value in the present relationship is .2. Hence, H_{11} is **Rejected** as outcome value do not have significant positive impact between behavior intention and use behavior as t-value is less than1.96.Result implies that there is no effect of firm size in adoption of green technology. If people are aware about atmosphere pollution then they will apply green technology in their firms, whether it is small or large.

Table 4.24: Hypothesis results of moderation.

Summary result of moderation					
		Original sample	**T statistics (|O/STDEV|)**	**P values**	**Empirical Calculations**

		(O)			
H_6	EXPERIENCE x SI->BI	-0.003	0.055	0.956	Rejected
H_7	EXPERIENCE x EE -> BI	0.017	0.517	0.605	Rejected
H_8	EXPERIENCE x FC -> UB	-0.254	5.741	0	Accepted
H_9	VOU x SI -> BI	-0.013	0.416	0.678	Rejected
H_{10}	EDUCATION x BI -> UB	-0.116	2.841	0.005	Accepted
H_{11}	FIRM_SIZE x BI -> UB	0.013	0.2	0.842	Rejected

(Source: Author's calculation)

CHAPTER-5

FINDINGS, CONCLUSIONS, IMPLICATIONS, LIMITATIONS AND RECOMENDATIONS

The results and observations from the study are highlighted in this chapter. SEM technique is used in the study, and SmartPLS 4.0 software is employed. Objectives are achieved on the basis of the results, given by SEM. Certain conclusions and implications are made and certain limitations have been observed. And, all of these aspects are discussed in this chapter.

5.1 Research Findings

On the basis of SEM, the following findings have been extracted which helped in achieving the objectives of the present study or research.

5.1.1To investigate whether Performance Expectancy (PE), Effort Expectancy (EE) and Social Influence (SI) affects decision maker's behavioural intention for green technology in brick kiln firms.

This research finds that PE is the main determinant in the suggested model. Research findings are in line with earlier study findings. (Zhang and Venkatesh, 2010; Tarhini et al., 2013a;Venkatesh et al., 2012; Ezzi, 2014). Therefore, users of technology in brick kilns are more likely to perceive using green technology favorably if they find it to be helpful. Thus, engineers or practitioners should enhance the quality of their technology based on user feedback in order to suit the demands of users and draw in more of them to green technology. Policymakers should provide comprehensive information on the benefits of green technology in the form of a user manual or description in order to improve conservation habits.

The results show that, in relation to the factors in the UTAUT model, construct effort expectancy significantly impact behavioural intention to use green technology. These findings are in line with the original theoretical foundations of the UTAUT model

(Kumar &Chand, 2019). The result shows a significant relationship between EE (Effort Expectancy) and BI (Behavioral Intention) to use green technology. This outcome also backs up by the UTAUT model's initial theory (Venkatesh et al., 2012; Kumar & Chand, 2019).

The outcome contradicts the UTAUT model's initial hypothesis in terms of social influence(Kumar and Chand, 2019). In this research, there is no statistically meaningful impact of SI (Social Influence) on BI (Behavioural Intention) to use green technology. Reason behind that people do not take much interest in technologies used in brick kilns or they do not have much knowledge about technologies used in brick kilns.

5.1.2 To examine the moderating role of demographic variables (experience and education) in the defined relationships among constructs taken.

The result indicates that Education is moderating behavior intention and use behavior of user. These findings are in line with the study previous study (Shita et al., 2018; A. Lleras-Muney et al., 2002), It concludes that users' education affects the chances, preferences, and decisions they make later in life. According to research, highly educated laborers are more willing to adopt new technologies than their less educated counterparts. This is because proper information and education flow reduces the costs and uncertainties associated with adopting new technologies.

Moderation of experience in study do not influence EE and SI, relationship with BI, (Nejadrezaei et al., 2018), while experience moderate the relationship between FC and UB significantly (Venkatesh et al., (2003); Salim et al., 2012)

5.1.3 To examine the moderating role of voluntariness to use and firm's size in the defined relationships among constructs taken.

The degree to which prospective adopters believe the adoption choice is voluntary is known as voluntariness (Ramayah, 2010;Prasad and Aggarwal, 1997).In the proposed model, this study discover that Voluntariness to use as a moderator do not have any significant impact on SI and BI. Findings of this study are in line with earlier study findings.

(Venkatesh, & Davis, 2000, Salim, 2012). For voluntariness variable Venkatesh justified it as "Voluntariness was a dummy variable used to separate the situational contexts." Consequently, if it has only one situational context, it might not be essential.

Askarany et al., (2010), Jacobsen et al., (2018) and S. Ishan (2018) argued that large industries or firms are more capable in adoption of new techniques or technology than the small one, but in brick kiln industry size of firm do not influence behavior intention and use behavior of brick kiln firms owners in context to adoption of new technology.

5.1.4 To investigate the influence of facilitating conditions (FC) on actual usage of the green technology.

Numerous studies (Yu, 2012; Zhang and Venkatesh, 2010; Venkatesh et al., 2003) have suggested that in the actual use of technology, FC play an important role, and the findings of this research support those studies when applied to green technology. Therefore, brick kiln owners are required to invest more in green technology and should also provide all necessary and basic facilities for the labor to increase their skills in using new technology.

5.1.5 To investigate the influence of behavior intention (BI) on actual usage of the green technology.

Results support past study by demonstrating that behaviour intention to use green technology results in actual technology use. (Venkatesh et al., 2003; D. Asamoah et al., 2018). Effort expectancy(EE) and Performance expectancy(PE) significantly impact behavior intention(BI) but on the other hand social influence do not have any impact on BI, still BI have a significant impact upon use behavior.

5.2 Conclusion

UTAUT model is applied in this research study to explain the key determinants that have effect on adoption or acceptance of green technology in brick kiln firms of Punjab. This research's findings are in line with the original theoretical foundations of the UTAUT model. The result of first construct PE (Performance Expectancy) shows that in brick kilns users are more likely to perceive using green technology favorably if they find it to be helpful. Same as PE, EE (Effort Expectancy) has a significant impact on the BI (Behavioural Intention) to use green technology. Findings show a significant relationship between EE and BI to use green technology. The outcome contradicts the UTAUT model's initial hypothesis in terms of social. In this research, there is no statistically meaningful impact of social influence on behavioural intention to use green technology. Reason behind that people do not take much interest in technologies used in brick kilns or they do not have much knowledge about technologies used in brick kilns. As previous studies, result of this research shows that facilitating conditions have significant impact on actual usage behavior in adoption of green technology.

As a moderator education has a significant impact on adoption of green technology in brick kiln firms. It shows that users' education affects the chances, preferences, and decisions they make later in life. High-skilled and educated workers tend to accept new technology more rapidly than less educated workers, according to research. On the other hand Moderation of experience in study do not influence EE and SI, relationship with BI, while experience moderate the relationship between FC and UB significantly. Another moderator voluntariness of use does not have any significant impact on SI and BI. Same as moderator firm size do not impact behavior intention and use behaviour. In brick kiln firms Findings of this study are in line with earlier study findings. as it has only one situational context. Some previous studies concluded that firms' size impact technology adoption but in brick kiln industry size of firm do not influence behavior intention and use behavior of brick kiln firms owners in context to green technology adoption. Findings show that behaviour intention to use green technology leads to real use of technology,

which is consistent with earlier research. Performance expectancy (PE) and effort expectancy (EE) significantly impact behavior intention (BI) but social influence do not have any impact on BI, still BI have a significant impact upon use behavior.

5.3 Implications

5.3.1 Theoretical Implications

The study tries to bring into knowledge the relationship of PE(Performance Expectancy), SI(Social Influence) and EE(Effort Expectancy) with BI(Behavior Intention) and, FC (Facilitating Conditions) with UB (Use Behavior)with respect to green technology adoption in brick kiln firms. It has been observed there is significant positive impact of PE and EE on BI and FC has significant positive impact on UB. Additionally, the study indicated that social influence had little effect on users' behaviour intentions. This contradicts earlier research that examined the importance of social influence on the behaviour of people in context to adoption of green technology. Hence, this research will motivate researcher to re-examine or recheck the role of social influence for further investigation.

Also, it is seen that there is significant moderation impact of experience on FC and UB. As a moderator education has significant positive impact on BI and UB. Therefore, policy makers and government should take into consideration the results. Though, there may be other product/service categories which also may be studied in future. The researchers shall extend the study further to enhance the knowledge base so that impact of above-mentioned constructs can be generalized.

5.3.2. Practical Implications

Brick kiln industry is a crucial sector of Punjab. State as well as center governments are giving attention towards reducing air pollution as well as conservation of soil and water. The UTAUT model is used in several studies to determine the various elements that affect the adoption of new technology. From this point forward, the study adds more moderators to the UTAUT. Policy makers, the government, and industrialists will benefit

from the study's understanding of the influence of several factors that lead to behaviour intention and actual usage or use behaviour towards the adoption of green technology in brick kiln industry.

As the researcher has come to the conclusion about the significant importance of EE(Effort Expectancy), PE(Performance Expectancy),and FC(Facilitating Conditions).Therefore, the technicians and marketers should focus on providing good deals to their customers by improving technologies as well as services. On the other hand, as findings shows that SI (social influence) does not impact behavior intention of users, it means that people of society are not aware about technology, used in brick kiln firms. This may be the reason of rising atmospheric pollution because if people is not aware about industry and its impact on atmosphere then who will complaint to government or concerned departments. This result will help government and policy makers to make policies or campaigns to aware people about the industries which may be harmful for atmosphere. The moderating role of experience and education cannot be ignored therefore, so, it is put forwarded that industrialist should consider these results during hiring of employees.

5.4 Limitations of the study

- **Sample population**: The population of Punjab State is the only one taken into account in this study.
- **Product type**: The present study is emphasized on green technology adoption in brick kiln firms only.
- **Biasness of respondents**: The respondents may not give right responses. The biasness may be due to lack of interest, or lack of understanding the questions etc. This may affect the results of the study but that is not under control of the researcher.
- **Generalizability**: As the research is restricted only on Punjab state population and green technology in brick kiln firms therefore the results achieved cannot be generalized to the whole universe.

5.5 Directions for Future research

- The area of research can be expanded out of Punjab to know the responses in other geographies too so that results can be generalized.
- The present research is focused only on brick kiln industry. The results may vary for different industries respectively. Therefore, it is recommended that additional study be done on other industries as well.

5.6 Recommendations

In the findings section, it was concluded that effort expectancy (EE) and performance expectancy (PE) significantly influence behavioral intention (BI), while social influences (SI) do not have a significant impact on behavioral intention (BI). This demonstrates a noteworthy relationship between PE and BI. Authorities and owners responsible for brick kiln operations believe that green technology is valuable for brick kiln firms. They have embraced it and believe that using green technology leads to greater success. Therefore, it is recommended that engineering firms should focus on enhancing the performance of technology, as it holds significant importance for users. Similarly, EE and PE significantly affect BI, as users of green technology find it easy to use. Therefore, engineering firms should prioritize the user-friendliness of green technology. The operation of technology should not be overly complicated for its users.

The findings show that there's a strong connection between how well things are set up (facilitating conditions - FC) and how people actually use the green technology (usage behavior - UB). When it comes to folks using green technology in brick kiln firms, it's all about how their workplace supports them, the training they receive, and how well the technology is integrated. So, for brick kiln owners, the key takeaway is to make sure they're providing the right support and conditions for their employees or workers if they want to see better results and more positive efforts with the green tech.

This study found that social influence (SI) doesn't have any bearing on how people intend to behave (behavioral intention - BI). It seems like the folks involved in brick kilns, both the workers and the decision-makers, don't pay much heed to what others have to say when it comes to embracing or rejecting green tech. This actually goes against what many previous studies, using the UTAUT model, have found. Typically, they've seen social influence as a big deal in shaping people's intentions. But in this research, it's a different story – SI doesn't move the needle when it comes to the intentions of green technology users. It might be because of the specific cultural context in this study, but it's making us think about things differently. In this particular setting, the brick kiln industry in Punjab, it seems that social influence doesn't impact the adoption of green technology. So, what's clear is that we need to do a better job of educating people about the importance of caring for the environment. Given these findings, the study recommends the following to the government:

Government needs to start awareness drives and campaigns, to aware society about green technologies used in different industries. Government should issue some orders like:

- Industrialist should mention on gate boards about technologies that they used in their industries.
- Government should do time to time survey of industries to check if they are using technologies as per rules and orders, to control pollution.

When we look at the experience of moderators, it's quite clear that it doesn't really change how much people are influenced by others or how easy they find using technology. But interestingly, it does have an impact on the conditions that make using technology smoother. So, it seems that when a technology is user-friendly, then it doesn't matter that if a user has a lot of prior experience or not. This tells us that engineers should really focus on making technology as easy as possible for users. On a different note, when it comes to education, it does make a difference in how people intend to behave and how

they actually use green technology. This suggests that educated users have a great impact on getting them to adopt green tech in brick kiln firms.

Now, as for the size of the firm, it doesn't seem to affect how people intend to behave or how they actually use green technology. In other words, whether a brick kiln firm is big or small, it doesn't seem to change their approach to adopting green tech. Another interesting finding is that the voluntariness of use (VOU) doesn't really sway people's opinions or actions when it comes to adopting green technology in brick kiln firms. It's worth noting that this result might be specific to this industry, as Venkatesh (2000) had identified VOU as a "dummy variable used to separate situational contexts." So, the influence of voluntariness may vary in different industries.

References

- Aaker, J.L. and Williams, P., 1998. Empathy versus pride: The influence of emotional appeals across cultures. *Journal of consumer research*, *25*(3), pp.241-261.
- Abdullah, M., Zailani, S., Iranmanesh, M. and Jayaraman, K., 2016. Barriers to green innovation initiatives among manufacturers: the Malaysian case. *Review of Managerial Science*, *10*, pp.683-709.
- Abu-Shanab, A. and Quigley, E.M., 2010. The role of the gut microbiota in nonalcoholic fatty liver disease. *Nature reviews Gastroenterology & hepatology*, *7*(12), pp.691-701.
- Aggarwal, M. L., 1968. Socio-Economic Conditions of Brick Kiln Workers in the Ghazipur Village. a research project report of Dept. of Sociology and Social Work, Lucknow University, published in P. Ramachandran (Ed.), Students Research Abstracts in Social Work, TISS.
- Aggarwal, M. L., 1968. Socio-Economic Conditions of Brick Kiln Workers in the Ghazipur Village. a research project report of Dept. of Sociology and Social Work, Lucknow University, published in P. Ramachandran (Ed.), Students Research Abstracts in Social Work, TISS.
- Aggarwal, R. and Karahanna, E., 2000. Time flies when you're having fun: Cognitive absorption and beliefs about information technology usage. *MIS quarterly*, pp.665-694.
- Aggarwal, R. and Prasad, J., 2000. A field study of the adoption of software process innovations by information systems professionals. *IEEE Transactions on Engineering Management*, *47*(3), pp.295-308.
- Ahmad, I. and Gao, Y., 2018. Ethical leadership and work engagement: The roles of psychological empowerment and power distance orientation. *Management Decision*, *56*(9), pp.1991-2005.

- Ahmer, Z., 2013. Adoption of human resource information systems innovation in Pakistani organizations. *Journal of Quality and Technology Management*, *9*(2), pp.22-50.
- Ajzen, I., 1980. Understanding attitudes and predicting social behavior. *Englewood cliffs*.
- Ajzen, I., 1991. The theory of planned behavior. Organizational behavior and human decision processes, 50(2), pp. 179-211.
- Al-Adwan, A. S., & Al-Horani, M. A., 2019. Boosting customer e-loyalty: An extended scale of online service quality. *Information*, 10(12), p.380.
- Alam, M. S., & Uddin, M. A., 2019. Adoption and implementation of enterprise resource planning (ERP): An empirical study. *Journal of Management and Research*, 6(1), pp.1-33.
- Alhirz, H. and Sajeev, A.S.M., 2015. Do cultural dimensions differentiate ERP acceptance? A study in the context of Saudi Arabia. *Information Technology & People*, 28(1), pp.163-194.
- Ali, M.; Miller, L., 2017. "ERP system implementation in large enterprises-A systematic literature review." *J. Enterp. Inf. Manag*, 30, pp. 666–692.
- Allen, M. W., & Brady, R. M., 1997. Total quality management, organizational commitment, perceived organizational support, and intra organizational communication. *Management Communication Quarterly*, *10*(3), pp. 316-341.
- Almahamid, S., 2019. The influence of ERP system usage on agile capabilities: examining the mediating role of users' psychological empowerment in Jordanian commercial banks. Information *Technology & People.*
- AlQudah, A.A., Al-Emran, M. and Shaalan, K., 2021. Technology acceptance in healthcare: A systematic review. *Applied Sciences*, *11*(22), p.10537.
- Al-Rahmi, W. M., Yahaya, N., Aldraiweesh, A. A., Alamri, M. M., Aljarboa, N. A., Alturki, U., &Aljeraiwi, A. A., 2019. Integrating technology

acceptance model with innovation diffusion theory: An empirical investigation on students' intention to use E-learning systems. *Ieee Access*, 7, pp.26797-26809.

- Al-Sabri, H.M.; Al-Mashari, M.; Chikh, A., 2018. A comparative study and evaluation of ERP reference models in the context of ERP IT-driven implementation: SAP ERP as a case study. *Bus. Process Mana*, 24, pp. 943–964.
- Amabile, T. M., 1988. A model of creativity and innovation in organizations. *Research in organizational behavior*, 10(1), pp. 123-167.
- Amabile, T. M., 1997. Entrepreneurial creativity through motivational synergy. *The journal of creative behavior*, 31(1), pp. 18-26.
- Amiya Rao, 1981. Brick Kiln Labour Living in Poverty and Bondage. *Economic and Political Weekly*, Vol. XVI, June 1981, p. 131.
- Anandhy, 1998. Some aspects of Capital and labour in brick industry-A case study of Melapuram block in Kanyakumari District. M.Phil dissertation submitted to J.N.U, New Delhi.
- Andrew Miller, 2000. Making of Fired Bricks in Tamil Nadu. Annual Report of MSME, Government of India, 2015-16.
- Arfi, W. B., Hikkerova, L., &Sahut, J. M., 2018. External knowledge sources, green innovation and performance. *Technological Forecasting and Social Change*, 129, pp. 210-220.
- Arora, A., Fosfuri, A. and Gambardella, A., 2004. Markets for technology: The economics of innovation and corporate strategy. *MIT press*.
- Arthur, W. B., 2011. The nature of technology: What it is and how it evolves. *New York: Free Press*.
- Asamoah, D. and Andoh-Baidoo, F.K., 2018. Antecedents and outcomes of extent of ERP systems implementation in the Sub-Saharan Africa context: A panoptic perspective. *Communications of the Association for information systems*, *42*(1), p.22.

- Aslam, 1993."Environmental Concerns in Brick Industry*". Annual 1993 Newsletter,* http://www.brickindia.com-corporate overview.
- Atlin, C., & Gibson, R., 2017. The Extractive Industries and Society.
- Awa, H.O.; Uko, J.P.; Ukoha, O., 2017. An Empirical Study of Some Critical Adoption Factors of ERP Software. *Int. J. Hum. Comput.* Interact, 33, pp. 609–622.
- Bagozzi, R. P., Davis, F. D., & Warshaw, P. R., 1992. Development and test of a theory of technological learning and usage. Human relations, 45(7), pp. 659-686.
- Bandura, A., 1977. Self-efficacy: toward a unifying theory of behavioral change. *Psychological review,* 84(2), p.191.
- Baptista, G., & Oliveira, T., 2015. Understanding mobile banking: The unified theory of acceptance and use of technology combined with cultural moderators. *Computers in Human Behavior*, 50, pp. 418-430.
- Baron, R. M., & Kenny, D. A., 1986. The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of personality and social psychology*, 51(6), p. 1173.
- Barrane, F.Z.; Karuranga, G.E.; Poulin, D., 2018. Technology Adoption and Diffusion: A New Application of the UTAUT Model. *Int. J. Innov. Technol. Management.* pp. 1950004–1950023.
- Bhanarkar, A. D., Gajghate, D. G., & Hasan, M. Z., 2002. Assessment of air pollution from small scale industry. *Environmental monitoring and assessment*, 80, pp. 125-133.
- Bhat, M.S., Afeefa, Q.S., Ashok, K.P. and Bashir, A.G., 2014. Brick kiln emissions and its environmental impact: A Review. Journal of Ecology and the Natural Environment, 6(1), pp.1-11.
- Bhattacharyya, H., 1957. The Cultural Heritage of India, Volume 4. *The Religions.*

- Bogers, M., Chesbrough, H., & Moedas, C., 2018. Open innovation: Research, practices, and policies. *California management review*, 60(2), pp.5-16.
- Brick architecture, (2017). https://brickarchitecture.com/about-brick/why-brick/why-brick
- Cavana, R., Delahaye, B., &Sekeran, U., 2001. Applied business research: Qualitative and quantitative methods. *John Wiley & Sons.*
- Chan, K. Y., Van Zwieten, L., Meszaros, I., Downie, A., & Joseph, S., 2007. Agronomic values of green waste biochar as a soil amendment. *Soil Research,* 45(8), pp. 629-634.
- Chang, C., & Glover, G. H., 2009. Effects of model-based physiological noise correction on default mode network anti-correlations and correlations. *Neuro image*, 47(4), pp. 1448-1459.
- Chang, C.K., Hayes, R.D., Perera, G., Broadbent, M.T., Fernandes, A.C., Lee, W.E., Hotopf, M. and Stewart, R., 2011. Life expectancy at birth for people with serious mental illness and other major disorders from a secondary mental health care case register in London. *PloS one,* 6(5), p.e19590.
- Chaouali, W., Yahia, I. B., &Souiden, N., 2016. The interplay of counter-conformity motivation, social influence, and trust in customers' intention to adopt Internet banking services: The case of an emerging country. *Journal of Retailing and Consumer Services,* 28, pp. 209-218.
- Chen, I. J., & Paulraj, A., 2004. Towards a theory of supply chain management: the constructs and measurements. *Journal of operations management,* 22(2), pp. 119-150.
- Chen, Y. S., 2008. The positive effect of green intellectual capital on competitive advantages of firms. *Journal of business ethics,* 77, pp. 271-286.
- Cheng, Y. M., 2018. What drives cloud ERP continuance? An integrated view. *Journal of Enterprise Information Management.*

- Cherukara, J. M., & Manalel, J., 2007. A Brief Account of SME Cluster Development in Kerala. In Biennial Conference Entrepreneur Development Institute of India. School of Management Studies, Cochin University of Science and Technology, Cochin. Kerala. Consultadoel (Vol. 15).
- Chesbrough, H., 2006. Open business models: How to thrive in the new innovation landscape. *Harvard Business Press.*
- Chin, W. W., 1998. The partial least squares approach to structural equation modeling. *Modern methods for business research*, 295(2), pp. 295-336.
- Chiou, T.Y., Chan, H.K., Lettice, F. and Chung, S.H., 2011. The influence of greening the suppliers and green innovation on environmental performance and competitive advantage in Taiwan. *Transportation Research Part E: Logistics and Transportation Review*, *47*(6), pp.822-836.
- Chopra, S. K., and Patwardan N. K., 1954. Survey on Brick Production in India. Bulletin of Central Building Research Institute, Roorkee, Vol.12. No.1, p.55.
- Chou, C.J., Chen, K.S. & Wang, Y.Y., 2012. "Green practices in the restaurant industry from an innovation adoption perspective: Evidence from Taiwan." *International Journal of Hospitality Management,* 31 (2012), pp. 703–711.
- Christino, J. M. M., Silva, T. S., Cardozo, E. A. A., de PáduaCarrieri, A., & de Paiva Nunes, P., 2019. Understanding affiliation to cashback programs: An emerging technique in an emerging country. *Journal of Retailing and Consumer Services,* 47, pp. 78-86.
- Christodoulides, G., &Michaelidou, N., 2010. Shopping motives as antecedents of e-satisfaction and e-loyalty. *Journal of Marketing Management,* 27(1-2), pp. 181-197.
- Claver-Cortés, E., López-Gamero, M. D., Molina-Azorín, J. F., &Tarí, J. J., 2006. Environmental management and firm performance: a case study.

- Costa, C. J., Ferreira, E., Bento, F., & Aparicio, M., 2016. Enterprise resource planning adoption and satisfaction determinants. *Computers in Human Behavior*, 63, pp. 659-671.
- CPCB. 2016. https://cpcb.nic.in/uploads/Latest_Final_Directions.pdf
- Dai, Y., Sun, Q., Wang, W., Lu, L., Liu, M., Li, J., Yang, S., Sun, Y., Zhang, K., Xu, J. and Zheng, W., 2018. Utilizations of agricultural waste as adsorbent for the removal of contaminants: A review. *Chemosphere*, *211*, pp.235-253.
- Daly, A. and Zannetti, P., 2007. An introduction to air pollution–definitions, classifications, and history. *Ambient air pollution. P. Zannetti, D. Al-Ajmi and S. Al-Rashied, The Arab School for Science and Technology and The Enviro. Comp. Institute*, pp.1-14.
- Dangelico, R. M., Pujari, D., &Pontrandolfo, P., 2017. Green product innovation in manufacturing firms: A sustainability-oriented dynamic capability perspective. *Business strategy and the Environment*, 26(4), pp. 490-506.
- Das, R., & Das, A. K., 2011. Industrial cluster: An approach for rural development in north east India. *International Journal of Trade, Economics and Finance*, 2(2), pp. 161.
- Davis, F. D., 1986. A technology acceptance model for empirically testing new end-user information systems. *Cambridge, MA*, p.17.
- Davis, F. D., 1989. Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS quarterly*, pp. 319-340.
- Davis, F. D., Bagozzi, R. P., & Warshaw, P. R., 1989. User acceptance of computer technology: A comparison of two theoretical models. *Management science*, 35(8), pp. 982-1003.
- Davis, F. D., Bagozzi, R. P., & Warshaw, P. R., 1992. Extrinsic and intrinsic motivation to use computers in the workplace 1. *Journal of applied social psychology*, 22(14), pp. 1111-1132.

- Davison, A. C., & Hinkley, D. V., 1997. Bootstrap methods and their application (No. 1). *Cambridge university press.*
- de Sena Abrahão, R., Moriguchi, S. N., & Andrade, D. F., 2016. Intention of adoption of mobile payment: An analysis in the light of the Unified Theory of Acceptance and Use of Technology (UTAUT). *RAI Revista de Administração e Inovação*, 13(3), pp. 221-230.
- Dharmalingam A.,1995. "Conditions of Brick Workers in South Indian Village", *Economic and Political Weekly*, Vol 26, No.11.
- Dixon, R. L., 1972. Toxicology of environmental agents: a blend of applied and basic research. *Environmental Health Perspectives.* 2, pp. 103-116.
- Dobson, E., 1890. Rudiments of the Art of Building: In Five Sections--general Principles of Construction; Materials Used in Building; Strength of Materials; Use of Materials; Working Drawings, Specifications, and Estimates (Vol. 22). *C. Lockwood and Son.*
- Dobson, E., 1893. A rudimentary treatise on the manufacture of bricks and tiles (Vol. 23). *C. Lockwood & Son.*
- Down to Earth report (March, 2019). https://www.downtoearth.org.in/blog/pollution/punjab-extends-time-for-brick-kiln-conversion-to-september-63532
- Eco-business, (2016). https://www.eco-business.com/news/controversy-over-how-indian-brick-kilns-clean-up-their-act
- El-Kassar, A.N. and Singh, S.K., 2019. Green innovation and organizational performance: The influence of big data and the moderating role of management commitment and HR practices. *Technological forecasting and social change*, *144*, pp.483-498.
- Eswaran, H., Beinroth, F., & Reich, P., 1999. Global land resources and population-supporting capacity. *American Journal of Alternative Agriculture*, 14(3), pp. 129-136.

- Ezzi, S. W., 2014. A theoretical Model for Internet banking: beyond perceived usefulness and ease of use. *Archives of business research*, *2*(2), pp. 31-46.
- Fatima, I., Bhat, G. A., & Kamili, A. N. G., 2011. Impact of brick kiln emissions on the ambient air quality and vegetation: A case study of district Budgam (Doctoral dissertation).
- Feder, G., Just, R.E. and Zilberman, D., 1985. Adoption of agricultural innovations in developing countries: A survey. *Economic development and cultural change*, *33*(2), pp.255-298.
- Fishbein, M., & Ajzen, I., 1977. Belief, attitude, intention, and behavior: An introduction to theory and research.
- Fisher, D. R., & Nasrin, S., 2021. Climate activism and its effects. Wiley Interdisciplinary Reviews: Climate Change, 12(1), p.e683.
- Flavián, C., Guinalíu, M., &Gurrea, R., 2006. The role played by perceived usability, satisfaction and consumer trust on website loyalty. *Information & management*, 43(1), pp.1-14.
- Foon, Y. S., & Fah, B. C. Y., 2011. Internet banking adoption in Kuala Lumpur: an application of UTAUT model. *International Journal of Business and Management*, 6(4), p.161.
- Fornell, C., & Larker, D., 1981. Structural equation modeling and regression: guidelines for research practice. *Journal of marketing research*, 18(1), pp.39-50.
- Gandhi, S., 1987. The brick industry in India: energy use, tradition and development (Doctoral dissertation, University of Cambridge).
- George, D., 2011. SPSS for windows step by step: A simple study guide and reference, 17.0 update, 10/e. Pearson Education India.
- Ghane, S. O. H. E. I. L. A., Fathian, M., & Gholamian, M. R., 2011. Full relationship among e-satisfaction, e-trust, e-service quality, and e-loyalty: The case of Iran e-banking. *Journal of Theoretical and Applied Information Technology*, 33(1), pp.1-6.

- Ghobakhloo, M., Hong, T. S., Sabouri, M. S., & Zulkifli, N., 2012. Strategies for successful information technology adoption in small and medium-sized enterprises. *Information*, 3(1), pp.36-67.
- Ghribi, A. M., Gafsi, I. M., Sila, A., Blecker, C., Danthine, S., Attia, H., ... &Besbes, S., 2015. Effects of enzymatic hydrolysis on conformational and functional properties of chickpea protein isolate. *Food chemistry*, 187, pp.322-330.
- GKSPL, (2013). Towards cleaner brick kilns in India. A win–win approach based on Zigzag firing technology. *Greentech Knowledge Solutions Pvt. Ltd, New Delhi*.
- Gopalakrishnan, S., &Damanpour, F., 1994. Patterns of generation and adoption of innovation in organizations: Contingency models of innovation attributes. *Journal of engineering and technology management*, 11(2), pp. 95-116.
- Grandon, E. E., & Mykytyn Jr, P. P., 2004. Theory-based instrumentation to measure the intention to use electronic commerce in small and medium sized businesses. *Journal of Computer Information Systems*, 44(3), pp.44-57.
- Grandon, E.E. and Pearson, J.M., 2004. Electronic commerce adoption: an empirical study of small and medium US businesses. *Information & Management*, Vol. 42, pp.197-216.
- Gulati, L., 1979. Female Labour in the Unorganised Sector: Profile of a Brick Worker. *Economic and Political Weekly*, pp.744-752.
- Guo, R., Wang, T. and Tao, L., 2008, September. Research on the effect mechanism of customer participation on new product development based on transaction cost theory: A knowledge sharing perspective. In *2008 International Conference on Management Science and Engineering 15th Annual Conference Proceedings* (pp. 1490-1495). IEEE.
- Gupta, J., 2003. Informal labour in brick kilns: need for regulation. Economic *and political weekly*, pp.3282-3292.

- Gupta, S., & Narayan, R., 2010. Brick kiln industry in long-term impacts biomass and diversity structure of plant communities. *Current science*, pp.72-79.
- Hair Jr, J. F., Sarstedt, M., Ringle, C. M., &Gudergan, S. P., 2017. Advanced issues in partial least squares structural equation modeling. *saGe publications.*
- Hasrini, Sari, &Firmanzah., 2009. Green Product Design: Identifying Determinant Factors That Influence Customers' Decision to Buy. *Proceedings of the 10th APIEMS Conference, Kitakyushu, Japan.*
- Henseler, J., Ringle, C. M., & Sinkovics, R. R., 2009. The use of partial least squares path modeling in international marketing. *In New challenges to international marketing. Emerald Group Publishing Limited.*
- Hillestad, T., Xie, C. and Haugland, S.A., 2010. Innovative corporate social responsibility: the founder's role in creating a trustworthy corporate brand through "green innovation". *Journal of Product & Brand Management*.
- Hiralal, E. S., & Majumdar, N. C., 2013. Modular Bricks–Semi Mechanized Manufacturing Process.
- Ho, A. T. K., & Ni, A. Y., 2004. Explaining the adoption of e-government features: A case study of Iowa county treasurers' offices. *The American Review of Public Administration*, 34(2), pp.164-180.
- Hu, P. J., Chau, P. Y., Sheng, O. R. L., & Tam, K. Y., 1999. Examining the technology acceptance model using physician acceptance of telemedicine technology. *Journal of management information systems*, 16(2), pp. 91-112.
- Huang, R. D., & Shiu, C. Y., 2009. Local effects of foreign ownership in an emerging financial market: Evidence from qualified foreign institutional investors in Taiwan. *Financial management*, 38(3), pp. 567-602.
- Hughes, A.D., Kelly, M.S., Black, K.D. and Stanley, M.S., 2012. Biogas from Macroalgae: is it time to revisit the idea?. *Biotechnology for bio-fuels*, *5*(1), pp.1-7.

- Hussain, B., Naqvi, S.A.A., Anwar, S., Shah, S.A.R., Hassan, R.H.U. and Shah, A.A., 2021. Zig-zag technology adoption behavior among brick kiln owners in Pakistan. Environmental Science and Pollution Research, 28, pp.45168-45182.
- Inbaraj, L.R., Haebar, O.J., Saj, F., Dawson, S., Paul, P., Prabhakar, A.K.P., Mohan, V.R. and Alex, R.G., 2013. Prevalence of musculoskeletal disorders among brick kiln workers in rural Southern India. Indian journal of occupational and environmental medicine, 17(2), p.71.
- Jacobsen, D. I., 2018. Adopting and Refining e-services-the Role of Organization Size. *Public Organization Review.* 18(1), pp. 111-123.
- JAIN, S. P., 1969. Thermal Performance of Perforated Brick, Hollow and Light-weight Block Construction in Tropics. *Architectural Science Review,* 12(1), pp.1–7
- Jen, W., Lu, T. and Liu, P.T., 2009. An integrated analysis of technology acceptance behaviour models: Comparison of three major models. *MIS REVIEW: An International Journal*, *15*(1), pp.89-121.
- Jusoh, Z. M., & Ling, G. H., 2012. Factors influencing consumers' attitude towards e-commerce purchases through online shopping. *International Journal of Humanities and Social Science*, 2(4), pp.223-230.
- Kammerer, D., 2009. The effects of customer benefit and regulation on environmental product innovation: Empirical evidence from appliance manufacturers in Germany. *Ecological Economics*, 68(8-9), pp.2285-2295.
- Karunakaran, 1975. Emerging trends in house construction. *Kerala productivity journal*, July- August 1975
- Kesharwani, A., & Singh Bisht, S., 2012. The impact of trust and perceived risk on internet banking adoption in India: An extension of technology acceptance model. *International journal of bank marketing*, 30(4), pp.303-322.

- Khalil, E., Abdalla, M. S., & Obada, A. S., 2010. Pair entanglement of two-level atoms in the presence of a non-degenerate parametric amplifier. *Journal of Physics B: Atomic, Molecular and Optical Physics,* 43(9), pp.095507.
- Khan, M. W., Ali, Y., De Felice, F., Salman, A., & Petrillo, A., 2019. Impact of brick kilns industry on environment and human health in Pakistan. *Science of the Total Environment,* 678, pp.383-389.
- Khan, R., & Vyas, H., 2008. A study of impact of brick industries on environment and human health in Ujjain City (India). *Journal of Environmental Research and Development,* 2(3), pp.421-425.
- Kioupis, D., Skaropoulou, A., Tsivilis, S. and Kakali, G., 2018. Development of Green Building Materials through Alkali Activation of Construction and Demolition Wastes.
- Koufaris, M., 2002. Applying the technology acceptance model and flow theory to online consumer behavior. *Information systems research,* 13(2), pp.205-223.
- Kumar, N. and Sidhu, A.S., 2005. Pull and Push Factors in Labour Migration: A Study of Brick Kiln Workers in Punjab. *Indian Journal of Industrial Relations,* Vol.42, No.2.
- Kubasiewicz, L.M., Watson, T., Norris, S.L., Chamberlain, N., Nye, C., Perumal, R.K., Saroja, R., Raw, Z. and Burden, F.A., 2022. One welfare: Linking poverty, equid ownership and equid welfare in the brick kilns of India. Animal Welfare, 31(4), pp.517-528.
- Lancaster, G. A., Dodd, S., & Williamson, P. R., 2004. Design and analysis of pilot studies: recommendations for good practice. *Journal of evaluation in clinical practice,* 10(2), pp.307-312.
- Lee, R. and Murphy, J., 2005. From Loyalty to Switching: Exploring the Determinants in Transition. *AZMAC Conference.*

- Lent, R. W., Brown, S. D., & Hackett, G., 1994. Toward a unifying social cognitive theory of career and academic interest, choice, and performance. *Journal of vocational behavior*, 45(1), pp. 79-122.
- Leonard, N.R., Silverman, M., Sherpa, D.P., Naegle, M.A., Kim, H., Coffman, D.L. and Ferdschneider, M., 2017. Mobile health technology using a wearable sensorband for female college students with problem drinking: an acceptability and feasibility study. *JMIR mHealth and uHealth*, *5*(7), p.e7399.
- Lin, C. Y., & Ho, Y. H.,2011. Determinants of green practice adoption for logistics companies in China. *Journal of business ethics*, 98, pp. 67-83.
- Lleras-Muney, A., & Lichtenberg, F. R., 2002. The effect of education on medical technology adoption: are the more educated more likely to use new drugs.
- Lleras-Muney, A., 2002. Were compulsory attendance and child labor laws effective? An analysis from 1915 to 1939. *The Journal of Law and Economics*, 45(2), pp. 401-435.
- Mahmood, M., Uddin, M. A., & Fan, L., 2019. The influence of transformational leadership on employees' creative process engagement: A multi-level analysis. *Management Decision,* 57(3), pp.741-764.
- Maithel, S., Uma, R., Bond, T., Baum, E., & Thao, V., 2012. Brick Kilns Performance Assessment A Roadmap for Cleaner Brick Production in India. *Shakti Sustainable Energy Foundation and Climate Works Foundation Supported Initiative, New Delhi.*
- Malhotra, N., Hall, J., Shaw, M., & Oppenheim, P., 2006. Marketing research: An applied orientation. *Deakin University.*
- Mallery, C. J., 2011. *The effects of neighborhood context and parenting factors on adolescent mental health: A multilevel investigation* (Doctoral dissertation, The George Washington University).

- Manoharan, G. 1998. “Scale, Technology and Efficiency in Brick Industry in Tamilnadu”, *Ph.D. Thesis submitted to ManonmaniamSundaranar University, Tirunelveli.*
- Martins, C., Oliveira, T., &Popovič, A., 2014. Understanding the Internet banking adoption: A unified theory of acceptance and use of technology and perceived risk application. *International journal of information management,* 34(1), pp.1-13.
- Mathur G.C., 1990. “Employment potential of Brick Industry”, Yojana, Vol.34 (5), pp.14-15
- Mitra, D., & Valette, D., Brick by Brick Environment, Human Labour, and Animal Welfare Unveiling the Full Picture of South Asia’s Brick Kilns Industry and Building the Blocks for Change. 2017.
- Moore, G.C. and Benbasat, I., 1991. Development of an instrument to measure the perceptions of adopting an information technology innovation. *Information systems research*, *2*(3), pp.192-222.
- Muhammad, D., Ismail, M.Y., Khan, F., Munsif, F., Ahmad, T., Ali, S., Khalid, M.J., Nur-ul-Haq, & Ahmad, M., 2012. Effect of brick kilns' emissions on heavy metal (Cd and Cr) content of contiguous soil and plants. *Sarhad Journal of Agriculture*, *28*, pp.165-170.
- Mussi, F. B., & Canuto, K. C., 2008. Percepção dos usuáriossobreosatributos de umainovação. *REGE Revista de Gestão*, 15, pp.17-30.
- Nagarajan . D., 1998. “The Neglected Brick Industry”. *Annual 1999 Newsletter,* http://www.brickindia.com- corporate overview.
- Nair, Ayyappan, 1973. “Clay Reserves in Kerala” paper presented in the seminar on ‘Tile industry in Kerala’ Trichur, May 1973 organized by Tile Manufacturers Association at Trichur.
- Nathonson, J.A., 2023. Environmental pollution.https://www.britannica.com/science/pollution-environment

- Nejadrezaei, N., Allahyari, M. S., Sadeghzadeh, M., Michailidis, A., & El Bilali, H., 2018. Factors affecting adoption of pressurized irrigation technology among olive farmers in Northern Iran. *Applied Water Science*, 8, pp. 1-9.
- Nemachinroyal.com, (2019). https://seo.checkup.tools/en/domain/nemachinroyal.com
- Oliveira, T., Thomas, M., Baptista, G., & Campos, F., 2016. Mobile payment: Understanding the determinants of customer adoption and intention to recommend the technology. *Computers in human behavior*, 61, pp.404-414.
- Oye, N. D., A. Iahad, N., & Ab. Rahim, N., 2014. The history of UTAUT model and its impact on ICT acceptance and usage by academicians. *Education and Information Technologies*, 19, pp.251-270.
- Pallant, J. F., & Bailey, C. M., 2005. Assessment of the structure of the Hospital Anxiety and Depression Scale in musculoskeletal patients. *Health and quality of life outcomes*, 3, pp.1-9.
- Pandey, Sarup and Prakash, June, 1985. Employment Generating Brick Kiln Industry. *Yojana*, Vol.32 (4).
- Pant, 2004. Hopeful of Boom in Manufacturing, The Hindu, Business Line. *(On line Edition) 8th January, 2004*, http://www. thehindubusinessline.com
- Patil, B. R., 1985. Brick Kiln Workers in Greater Bangalore. *Indian Journal of Labour Economics*, 27(4), pp. 301-309.
- Perneger, T. V., Courvoisier, D. S., Hudelson, P. M., &Gayet-Ageron, A., 2015. Sample size for pre-tests of questionnaires. *Quality of life Research*, 24, pp. 147-151.
- Peterson, S. J., & Bredow, T. S. (Eds.)., 2009. Middle range theories: Application to nursing research. *Lippincott Williams & Wilkins.*
- Pellenq, C., Gunn, S. and Lima, L., 2021. The psychological health and well-being of children working in the brick industry: A comparative study. Safety science, 140, p.105251.

- Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P., 2003. Common method biases in behavioral research: a critical review of the literature and recommended remedies. *Journal of applied psychology*, 88(5), p.879.
- Pokhrel, R., & Lee, H., 2011. Estimation of the effective zone of sea/land breeze in a coastal area. *Atmospheric Pollution Research*, 2(1), pp.106-115.
- Porter, M.E. and Kramer, M.R., 2018. Creating shared value: How to reinvent capitalism—And unleash a wave of innovation and growth. In *Managing sustainable business: An executive education case and textbook* (pp. 323-346). Dordrecht: Springer Netherlands.
- PPCB, 2022. https://ppcb.punjab.gov.in/sites/default/files/2020-03/brickkiln.pdf
- Prasad, D., & Sanyal, S., 2016. A study of air quality and its effect on health: a geographical perspective of Lucknow city. *Space and Culture, India,* 4(1), pp.51-64.
- Puri, A., 1983. The Season that Never Started. *Business India*.
- Raheja, R., Regev, K., Healy, B.C., Mazzola, M.A., Beynon, V., Von Glehn, F., Paul, A., Diaz-Cruz, C., Gholipour, T., Glanz, B.I. and Kivisakk, P., 2018. Correlating serum micrornas and clinical parameters in amyotrophic lateral sclerosis. *Muscle & nerve*, *58*(2), pp.261-269.
- Rahi, S., & Abd. Ghani, M., 2018. The role of UTAUT, DOI, perceived technology security and game elements in internet banking adoption. *World Journal of Science, Technology and Sustainable Development,* 15(4), pp.338-356.
- Rahi, S., Mansour, M. M. O., Alghizzawi, M., &Alnaser, F. M., 2019. Integration of UTAUT model in internet banking adoption context: The mediating role of performance expectancy and effort expectancy. *Journal of Research in Interactive Marketing.*

- Rajan, C. A., & Baral, R., 2015. Adoption of ERP system: An empirical study of factors influencing the usage of ERP and its impact on end user. *IIMB Management Review*, 27(2), pp. 105-117.
- Rajarathnam, U., Athalye, V., Ragavan, S., Maithel, S., Lalchandani, D., Kumar, S., Baum, E., Weyant, C. and Bond, T., 2014. Assessment of air pollutant emissions from brick kilns. *Atmospheric Environment*, *98*, pp.549-553.
- Raman, A., & Don, Y., 2013. Preservice teachers' acceptance of learning management software: An application of the UTAUT2 model. *International Education Studies*, 6(7), pp.157-164.
- Ramayah, T., 2010. The Role of Voluntariness in Distance Education Students' Usage of a Course Website. *Turkish Online Journal of Educational Technology-TOJET*, 9(3), pp.96-105.
- Rana, N. P., & Dwivedi, Y. K., 2015. Citizen's adoption of an e-government system: Validating extended social cognitive theory (SCT). *Government Information Quarterly*, 32(2), pp.172-181.
- Randeria and Yagnik. 1983. Non-Implementation of Labour Laws in Brick Kiln in Gujarat. *Economic and Political Weekly*, Vol XIV (18).
- Raykov, T., 2007. Reliability if deleted, not 'alpha if deleted': Evaluation of scale reliability following component deletion. *British Journal of Mathematical and Statistical Psychology*, 60(2), pp.201-216.
- Reuters, 2019. End bondage, demand millions of Indian brick kiln workers as polls loom. *THOMSON REUTERS FOUNDATION*, March, 29. https://www.reuters.com/article/india-labour-bondage-idINKCN1RA0NK
- Rogers, E. M., & Shoemaker, F. F., 1971. Communication of Innovations; a cross-cultural approach.
- Rogers, E. M., 1983. "Diffusion of innovations (3rd ed.)". *New York: The Free Press.*

- Rothenberg, S., &Zyglidopoulos, S. C., 2007. Determinants of environmental innovation adoption in the printing industry: the importance of task environment. *Business Strategy and the Environment,* 16(1), pp.39-49.
- Ruma Ghosh, 2005. Brick Kiln Workers: A Study of Migration, Labour Process and Employment, National Labour Institute. *(An Autonomous Body of Ministry of Labour, Government of India)*, No.57.
- Rusinko, C., 2007. Green manufacturing: an evaluation of environmentally sustainable manufacturing practices and their impact on competitive outcomes. *IEEE transactions on engineering management*, *54*(3), pp.445-454.
- Salim, B., 2012. An application of UTAUT model for acceptance of social media in Egypt: A statistical study. *International Journal of Information Science*, 2(6), pp.92-105.
- Sarvepalli, R., 2015. "The Cultural Heritage of India." https://archive.org/details/in.ernet.dli.2015.284
- Searle, Alfred B., 1877-1967: *Modern brickmaking,* (London, Scott, Greenwood & son, 1920)
- Shanmugapriya, R., 2019. *Study of Coagulation Profile in Type 2 Diabetes Mellitus Patients in Correlation with Long Term Glycemic Control (HBA1C)* (Doctoral dissertation, Coimbatore Medical College, Coimbatore).
- Sharan, M., Yadav, A. K., Singh, M. P., Agarwal, P., & Nigam, S., 1996. A mathematical model for the dispersion of air pollutants in low wind conditions. *Atmospheric Environment,* 30(8), pp.1209-1220.
- Shiva, A., Narula, S., & Shahi, S. K., 2020. What drives retail investors‟ investment decisions? Evidence from no mobile phone phobia (Nomophobia) and investor fear of missing out (I-FoMo). *Journal of Content, Community and Communication,* 10(6), pp.2-20.
- Show, P. L., Lau, P. L., & Foo, D. C., 2018. Green technologies: innovations, challenges, and prospects. *Clean Technologies and Environmental Policy*, 20(9), pp.1939-1939.

- Singh, D. P., 2005. Women workers in the brick kiln industry in Haryana, India. *Indian Journal of Gender Studies*, 12(1), pp.83-97.
- Singh, D.P., 2003. Living Conditions of Women in Brick Kiln Industry of India: Reflecting the agenda for social work intervention.
- Skinder, B. M., Pandit, A. K., Sheikh, A. Q., & Ganai, B. A., 2014. Brick kilns: cause of atmospheric pollution. *J Pollut Eff Cont*, 2(112), p.3.
- Slade, S., & Prinsloo, P., 2013. Learning analytics: Ethical issues and dilemmas. *American Behavioral Scientist*, 57(10), pp.1510-1529.
- Solodky, M., 2006. *The Technology of Ancient Egypt*. The Rosen Publishing Group, Inc.
- Song, K., Wang, Z., Du, J., Liu, L., Zeng, L., & Ren, C., 2014. Wetland degradation: its driving forces and environmental impacts in the Sanjiang Plain, China. *Environmental Management*, 54, pp.255-271.
- Stal, E., 2007. Inovação à brasileira. *GV-executivo*, *6*(1).
- Swamy, K.,1971. Treasure of the Earth: Minerals. *Tamil Nadu Textbook Society, Madras*.
- Gupta, S., Tandon, S., Singh, S., & Kumar, A., 2017. Respiratory abnormalities among occupationally exposed, non-smoking brick kiln workers from Punjab, India. *The International Journal of Occupational and Environmental Medicine*, 8(3), pp.166.
- Tarhini, A., Hone, K. S., & Liu, X., 2013. Factors affecting students' acceptance of e-learning environments in developing countries: a structural equation modeling approach.
- Teare, M. D., Dimairo, M., Shephard, N., Hayman, A., Whitehead, A., & Walters, S. J., 2014. Sample size requirements to estimate key design parameters from external pilot randomised controlled trials: a simulation study. *Trials*, 15, pp.1-13.
- Tenenhaus, M., Vinzi, V. E., Chatelin, Y. M., & Lauro, C., 2005. PLS path modeling. *Computational statistics & data analysis*, 48(1), pp.159-205.

- TOI. 2019. No high court relief to Punjab brick kilns over not adopting.https://timesofindia.indiatimes.com/city/chandigarh/no-hc-relief-to-punjab-brick-kilns-over-not-adopting-new-emission-technology/articleshow/71431784.cms
- Turner, J. C., 2010. Social categorization and the self-concept: a social cognitive theory of group behavior.
- Ullah, M.M., 2017. Integrating environmental sustainability into human resources management: A comprehensive review on green human resources management (Green HRM) Practices. *Economics and management*, *6*(1), pp.14-19.
- UNCTAD., 2018. Technology and innovation report 2018: Harnessing frontier technologies for sustainable development.
- Upadhye-Chavan V.D. (1991). "A Socio Economic Survey of Immigrant Labour in Brick Making Industry in the Sangli District", *Shivaji University, Kolhapur,* 1991.
- Varghese, J., & Rajagopal, K., 2013. Development of a new tool for evaluating postnatal mother's satisfaction following nursing care: in India. *Development,* 3(9), pp.45.
- Varghese, B., Issac, S.S. and Varghese, J., 2020. A Descriptive Study to Assess the Level of Stress among Elderly People Residing at Old Age Homes, Uttar Pradesh (India). Age (years), 60(65), p.14.
- Venkatesh, V., & Davis, F. D., 2000. A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management science,* 46(2), pp.186-204.
- Venkatesh, V., & Speier, C., 1999. Computer technology training in the workplace: A longitudinal investigation of the effect of mood. *Organizational behavior and human decision processes,* 79(1), pp.1-28.

- Venkatesh, V., & Speier, C., 2000. Creating an effective training environment for enhancing telework. *International Journal of Human-Computer Studies*, 52(6), pp.991-1005.
- Venkatesh, V., & Zhang, X., 2010. Unified theory of acceptance and use of technology: US vs. China. *Journal of global information technology management*, 13(1), pp.5-27.
- Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D., 2003. User acceptance of information technology: Toward a unified view. *MIS quarterly*, pp.425-478.
- Venkatesh, V.; Thong, J.Y.; Xu, X., 2012. "Consumer Acceptance and Use of Information Technology: Extending the Unified Theory." 36, pp.157–178.
- Walter, T., Hein, T., Weichselgartner, M., Wommer, K., Aust, M. and Vogel, N., 2022. Dispersion-based, scalable fabrication of repellent superhydrophobic and liquid-infused coatings under ambient conditions. *Green Chemistry*, *24*(7), pp.3009-3016.
- Wang, H., Khan, M. A. S., Anwar, F., Shahzad, F., Adu, D., & Murad, M., 2021. Green innovation practices and its impacts on environmental and organizational performance. *Frontiers in Psychology*, 11, pp.553625.
- Wang, Q., Qu, J., Wang, B., Wang, P., & Yang, T., 2019. Green technology innovation development in China in 1990–2015. *Science of the Total Environment*, 696, pp.134008.
- Weick, K.E. and Quinn, R.E., 1999. Organizational change and development. *Annual review of psychology*, *50*(1), pp.361-386.
- Weng, H. H., Chen, J. S., & Chen, P. C., 2015. Effects of green innovation on environmental and corporate performance: A stakeholder perspective. *Sustainability*, 7(5), pp.4997-5026.
- Wetzels, M., Odekerken-Schröder, G. and Van Oppen, C., 2009. Using PLS path modeling for assessing hierarchical construct models: Guidelines and empirical illustration. *MIS quarterly*, pp.177-195.

- Whitehead, A. L., Julious, S. A., Cooper, C. L., & Campbell, M. J., 2016. Estimating the sample size for a pilot randomized trial to minimize the overall trial sample size for the external pilot and main trial for a continuous outcome variable. *Statistical methods in medical research,* 25(3), pp.1057-1073.
- World Health Organization, (2022). https://www.who.int/health-topics/environmental-health#tab=tab_1
- Yadav, R. K., Yadav, D. S., Rai, N., & Patel, K. K., 2003. Prospects of horticulture in north eastern region. *HIMALAYAN ECOLOGY,* 11(2), pp.13.
- ZAWISLAK, P. A., 1995. A relação entre conhecimento e desenvolvimento: essência do progressotécnico. *Análise,* 6(1), pp.125-149.
- Zhang, P., Li, N. and Sun, H., 2006, January. Affective quality and cognitive absorption: Extending technology acceptance research. In *Proceedings of the 39th Annual Hawaii International Conference on System Sciences (HICSS'06)* (Vol. 8, pp. 207a-207a). IEEE.
- Zhu, H., Ou, C. X., van den Heuvel, W. J. A., & Liu, H., 2017. Privacy calculus and its utility for personalization services in e-commerce: *An analysis of consumer decision-making. Information & Management,* 54(4), pp.427-437.

Appendix

Schedule

S. No._____

Dear Respondent,

I am Ajay Kumar, PhD. Research Scholar of Lovely Professional University doing research in Marketing. My research topic is **"Acceptance and Usage of Green Technology in Brick Kiln Firms of Punjab: An Application of the Unified Theory of Acceptance and Use of Technology (UTAUT) Model".** The information provided by you will be kept confidential and will be used for academic research purpose only.

Section-1: Demographic Profile

Name of Firm	
City	
Districts	Amritsar☐ Barnala☐ Bathinda☐ Faridkot☐ Fatehgarh Sahib☐ Fazilka☐ Ferozepur☐ Gurdaspur☐ Hoshiarpur☐ Jalandhar☐ Kapurthala☐ Ludhiana☐ Mansa☐ Moga☐ Sri Muktsar Sahib ☐ Nawanshahr (SBS)☐ Pathankot☐ Patiala☐ Roopnagar☐ SAS Nagar (Mohali)☐ Sangrur☐ Tarn Taran☐
Name of the Respondent	
Gender	Male ☐ Female ☐
Age (in years)	
Position	Owner ☐ Supervisor ☐ Thekedar ☐ Munshi☐ Any other ☐
Experience	Less than 5years ☐ 6-10 ☐ 11-15 ☐ More than 15 years☐
Education	High School ☐ Graduation ☐ Post Graduation ☐ Any

	Other☐
Locality	Rural ☐ Urban ☐
Age of Firm	Below 1 year ☐ 1- 5 years ☐6-10 years ☐ Above 10 years ☐
Number of employees	1-10 ☐ 11-20 ☐ 21-30 ☐ 31-40 ☐ Above 40 ☐
Firm Size (Production)	Small (Below 15,000 bricks per day) ☐ Medium (16,000-30,000) ☐ Large (above 30,000) ☐
Are you aware about Green Technology (GT).	Yes ☐ No ☐
Using any type of GT.	Yes ☐ No ☐
Is there any type of pressure from government to use GT?	Yes ☐ No ☐
Abbreviations	**Meaning**
GT	Green Technology

II. For each of the following statements kindly indicate your answer by putting (✓) on right option ranging between **5-Strongly Agree, 4-Agree, 3-Undecided, 2-Disagree, 1-Strongly Disagree.**

1. **Performance Expectancy:**

Sr. No.	Statements	1	2	3	4	5
1	Adoption of Green Technologies is useful in production of brick kiln firms.					
2	Green Technologies disable the firms to accomplish tasks quickly.					
3	Green Technologies adoption increases productivity without causing any effect on health of labourer or society.					
4	Use of the Green Technologies in brick kilns gives more accuracy in work.					
5	Using Green Technologies improves the					

	firm's Production process.					
6	Green technology helps firms in conservation of water and soil.					
7	Green technology helps brick kiln firms to control air pollution.					
8	If firm uses any Green Technology, it will increase firm's chances of getting a raise.					
9	Using Green Technologies enables to accomplish work more efficiently.					
10	Use of Green Technologies does not enhance effectiveness of labourer during work.					
11	By using Green Technologies, I can increase the chances of receiving good feedback from customers.					

2. Effort Expectancy:

Sr. No.	Statements	1	2	3	4	5
1	It is not easy for labourer or workers to become more skilful by use of green technologies.					
2	Interaction with Green Technologies is clear and understandable.					
3	Labourer or workers of the firm find the Green Technologies easy to use.					
4	Learning to work with Green Technologies is easy for employees or labourer.					
5	Learning to operate the Green Technologies is easy for workers or labourer.					
6	Labourer or workers would become proficient by the use of Green Technologies.					
7	Use of Green Technology takes too much time to perform normal duties.					

3. Social Influence:

Sr. No.	Statements	1	2	3	4	5
1	People who influence my behaviour think that I should use the Green Technologies in my firm.					
2	People who are important or close to me					

	think that I should adopt and use the Green Technologies.					
3	The Government supports the use of Green Technologies.					
4	A specific person or group is available for assistance if labourer or workers experience any difficulty with Green Technologies.					
5	I think society appreciates that firm or organizationwhich uses Green Technologies.					
6	Workers or labourer work more efficiently by using Green Technologies.					

4. Facilitating Conditions:

Sr. No.	Statements	1	2	3	4	5
1	Workers or labourer have the resources which are necessary to use in Green Technologies.					
2	Workers or labourerdo not need necessaryknowledge to use the Green Technologies.					
3	The Green Technologies are mostly compatible with other systems used by labourer or workers.					
4	I think that using Green Technologies fits well with the way labourer or workers like to work.					
5	In general, provincial PPCB office has also supported the use of Green Technologies.					
6	There is a support available to assist when difficulties arise during use of Green Technologies.					
7	Workers or labourer have knowledge sources like manuals, instructors, documents, consultants etc. for the proper use of Green Technologies.					

5. Behavior Intention:

Sr. No.	Statements	1	2	3	4	5
1	I will continue to use the latest Green Technologies available in the market.					

2	I will use Green Technologies in my firm in future also.					
3	Intend to use new Green Technologies in the next season.					
4	I predict I would use the Green Technologies in next season.					
5	I plan to use the new Green Technologies in the next season.					
6	I would use Green Technologies to improve production process.					

6. Use Behavior:

Sr. No.	Statements	1	2	3	4	5
1	I prefer to use Green Technologies.					
2	I like to use Green Technologies.					
3	Use of Green Technologies is a pleasant experience.					

7. Voluntariness of Use:

Sr. No.	Statements	1	2	3	4	5
1	Although it might be helpful, using Green Technologies are certainly not compulsory in my firm.					
2	Customers or workers do not require me to use Green Technologies.					
3	Society expects me to use Green Technologies.					
4	I value environment friendly products.					

Thank You

Annexure

Conferences Details					
S.No	**Conference Name**	**Organizer**	**Presentation**	**Title of the Paper**	**Conference Date**
1	International multidisciplinary conference on innovative solutions for future	GHG Khalsa College	No	_____	30th October,2022
2	Industry 5.0: Human Touch, innovation and efficiency	Lovely Professional University	Paper	Adoption of water and soil conservation practices in brick kiln industry: Theoretical frameworks and attitudinal components	28-Jan-22
3	International conference on emerging trends in science, engineering and management	GM institute of Technology	Paper	Impact of advanced technology adoption on customer satisfaction: An empirical study with reference to Pizza industry	15-16th July 2021
4	Management Conclave-2019	Lovely Professional University	No	----------	7-8th November, 2019
5	ECON-2024	International Student Scientific Conference ECON-2024: WORLD ECONOMY AND INTERNATIONAL BUSINESS	Paper	MODERN TRENDS IN THE DEVELOPMENT OF THE WORLD ECONOMY; ADOPTION OF INNOVATION IN THE BRICK KILN INDUSTRY OF PUNJAB	20th April, 2024

Publication Details					
S.No	**Type of Paper (Journal Paper/Conference proceeding/Book Chapter)**	**Name of the Journal/Conference/Book**	**Journal indexing (Scopus/UGC/Web of Science)**	**Title of the Paper**	**Published Date**
1	Journal Paper	Asian Journal of Organic & Medicinal Chemistry	UGC	Technology Adoption Models: A Study on Brick Kiln Firms in Punjab	April-June 2022
2	Journal Paper	Journal of pharmaceutical negative results	SCOPUS	Integration of UTAUT model in context to Zigzag technology adoption in brick kilns of Punjab	7-Feb-23
3	Journal Paper	Annals of Bhandarkar oriental research institure	UGC	Impact of facilitating conditions in adoption of Zigzag technology in brick kiln of Punjab	25-Jnauary-24

Technologies patent details			
S.No	**Technology Name**	**Year**	**Stage**
1	Water Tank Filter	2024	On grant stage
2	Reuse of hot air in brick kiln through ducting	2024	Sent for publication

Workshops Details			
S.No	**Workshop name**	**Organizer**	**Workshop Date**
1	Emerging pedagogical and research trends in business management	GNA	19-20th June, 2021
2	Workshop on structural equation modeling using AMOS	Oriental University Indore	11-15th May, 2020